NOTE ON SORGHO

WIGLEY

00054892

NOT TO BE ISSUED
OUT OF THE LIBRARY.

633.174
Wig/Not
54892

B. B. R. A. S.

BOMBAY BRANCH
OF THE
ROYAL ASIATIC SOCIETY.
TOWN HALL, BOMBAY.

Digitized with financial assistance from the
Government of Maharashtra
on 18 July, 2018

00054892

ROYAL ASIATIC SOCIETY LIBRARY OF THE BOMBAY BRANCH

CONTENTS.

	PARA.
Botanical notice	1—3
Introduction of Sorgho into Europe and America	4—7
Botanical history of the plant	8
Description	9—10
Value of the plant: its properties	11—17
Review of its cultivation in America	18—29
Value of Sorgho as a forage plant	30
Culture	31—33
Uses in China and Africa	34
Introduction into India in 1858, and results of the first experiments made	36—38
Madras—Experiments on the Government Farms, 1870-71	39—42
Condition of Sorgho in other parts of India until brought specially to notice by Colonel Boddam in 1871	43—44
Colonel Boddam's Memorandum—His experiences of Sorgho	45—47
Experiments in Mysore	49—54
„ in Bombay	55—57 & 60
„ in Sind	58—59
„ in Bengal	61—63
„ in the North-Western Provinces	64—73
„ in Oudh	74—78
„ in the Central Provinces	79—80
„ in the Hyderabad Assigned Districts	81
„ in the Punjab	82—87
Yield of seed and fodder from experiments in India	88
General results of Sorgho cultivation in India	89—92

V

633.174.
Wij/Nol
54892

NOTE ON SORGHO

(SORGHUM SACCHARATUM).

THE great want of good, succulent fodder grasses in India, is a subject that has frequently engaged the attention of the Government of this country. The chief causes of insufficiency of pasture are want of moisture, want of manure, a bad system of agriculture, and the general carelessness of the native cultivators in everything relating to the well-being of their stock, Indian cultivators being proverbially neglectful of their beasts, although they are their main resource. Various attempts have, from time to time, been made to improve this state of things, either by the experimental cultivation under a better system of agriculture of indigenous fodder plants, or by the introduction from other countries of fodder-yielding plants and grasses which there has been reason to believe would thrive in India. Among the best of these, Sorgho, the Northern Chinese sugarcane, takes prominent rank. This plant, as its name indicates, is a native of the north of China, and among its popular names are "sorgho," "sorghum," "sorgho sucré," "Chinese sugarcane," and "imphee." It is of the Natural order named *Holcus saccharatus* and *Sorghum saccharatum*. There are several species of *sorghum* cultivated in India. They are—

Botanical notice.

(1.) The *Sorghum vulgare:* synonyms, *Holcus sorghum*, *Holcus durra*, and *Andropogon sorghum*, the produce of which is called "jowar" or "janeera" in Bengal, and "cholum" and "jonna" in the Madras Presidency. This jowar, which is known as the "great Indian millet," is also extensively cultivated in other parts of Asia and in the West Indies, and indeed it is grown in almost all tropical countries.

(2.) *Sorghum halepense*, the synonyms of which are *Holcus cernuus* and *Andropogon cernuus*, known as the "shaloo" of the Deccan, and grown in the Broach districts of the Bombay Presidency under the name of "soondia."

(3.) *Holcus bicolor: syn. Andropogon bicolor*, known as the "black deodhan" or "black jowar."

(4.) The *Andropogon saccharatus* of Roxburgh, known as the "white deodhan" of Bengal. Dr. Roxburgh was uncertain whether this was the *Holcus saccharatus* of Linnæus, and Mr. John Scott, Curator of the Royal Botanical Gardens at Calcutta, who wrote a memorandum on the *Sorghum saccharatum* and *Sorghum vulgare*, thought that the "white deodhan" was merely a variety of the *Sorghum vulgare*, Pers., and not a distinct species at all. The following is an extract from the memorandum referred to:—

"The *Sorghum vulgare*, Pers., is the "jowar" of the Bengalees—the *Andropogon sorghum* of Roxburgh; and the *Andropogon saccharatus* of the latter author—the "deodhan" of the Bengalees—is but a variety with muticous valves. The *Holcus saccharatus*, Linn., is described '*glumis glabris, seminibus muticis,*' so that Roxburgh errs in the remark that 'the only circumstance that renders me uncertain whether this is the *Holcus saccharatus* of Linnæus is the total want of the arista in the hermaphrodite flowers.' Botanists very generally distinguish the *sorghum vulgare* and *sorghum saccharatum* by the former having a contracted and more or less erect inflorescence with villose glumes and awned seeds, whereas the latter has an open, frequently drooping inflorescence,

* In this note I have used the term "sorgho" generally, to denote the Chinese Sorgho and the African Imphee together as mere varieties of the *Sorghum saccharatum*. Where the "Chinese Sorgho" and the "Imphee" are referred to separately and independently of each other, these two terms respectively are used.—F. G. W.

glabrous glumes, and muticous seeds. These are, however, but extremes or well-marked varieties of a single species, inseparably united by other cultivated forms, as are several others of the so-called species of sorghum, judging from the living specimens which I have examined in the Botanic Gardens here and of which the seeds were received direct from Professor Todaro, Palermo. Indeed, Mr. Bentham, in his review of Professor Targioni-Toz-Zetti's 'Historical Notes on Cultivated Plants,' is, as will be seen from the following quotation, disposed to reduce all to a single species; thus,—'As to the cultivated sorghums, most botanists distinguish several species, although none are to be found in a wild state except those which have a more diffuse panicle with less crowded flowers, and which come the nearest to the more luxuriant specimens of the *Sorghum halepense*, which is very abundant and wild in some parts of Southern Europe, and all over Africa and India. Indeed, we believe it to be the opinion of an eminent agrostologist, who has shown the soundest judgment in the investigation of East Indian and other gramineæ,—an opinion in which we fully concur,—that the described species of sorghum are mostly, if not all, mere varieties of the *Sorghum halepense*, produced by extensive cultivation during a long series of ages.'"

2. The opinion that all the species of sorghum mentioned above are but different varieties of the same original plant is also brought forward by Olcott in his treatise on the "Sorgho and Imphee," published at New York in 1857. Discussing the botanical history of the Chinese Sorgho, at page 32 of this work, he refers to a paper on the subject which was read to the Boston Society of Natural History, of which the following is an extract:—

"Both *Sorghum vulgare* and *Sorghum saccharatum* are recorded as distinct species, but there is frequently a query appended to the latter. Some of our best authorities incline to the opinion that these two are identical, the differences between them being due to the long cultivation which the plant has undergone. We know that some of the grasses have sprouted into numerous varieties; and it is very probable that the Broom Corn, Doura or Guinea Corn, and the Chinese Sugarcane, are all descended from one and the same stock."

The Indian jowar.

3. However, from experiments made in India, it has been proved that the Sorgho (*Sorghum saccharatum*) which has been so long under cultivation in China is a much finer plant than the most common and best in this country of the cultivated varieties of the *Sorghum vulgare*, *viz.*, the jowar; growing to a much greater height, containing much more saccharine matter in the stem, and, possessing the faculty of rattooning, giving three or more cuttings in one season from one sowing, while more than one cutting is not ordinarily obtainable from the jowar. The experiments made in India with sorgho have been undertaken chiefly with a view to compare its value with that of the jowar, which is so extensively cultivated throughout the country for grain and forage; and it will be one of the objects of this note to shew from these experiments the value of sorgho in comparison with the jowar, and to consider how far it is likely to replace that plant in the estimation of those who cultivate it for forage.

Introduction of the Chinese Sorgho into Europe.

4. The Chinese Sorgho was first introduced into Europe in the year 1851 when the French Consul at Shanghai, the Count de Montigny, sent some seeds, together with seeds of other Chinese plants which he thought would succeed in France, to the Geographical Society at Paris. In France the sorgho was highly appreciated, and the subject received much attention at the hands of scientific men, who made experiments in extracting the different products which the plant will yield. Very satisfactory results attended these experiments, and many articles, pamphlets, and books were written on the sorgho, some of which, translated, form an appendix to Olcott's work above referred to.

In the following year, 1852, eight hundred seeds of the sorgho, which had been raised by a gardener at Hyères, were sold to a firm of seed-merchants in Paris at the rate of a franc a-piece, and from that time the sorgho has completely established itself in France.

Introduction into America.

5. From France seed quickly found its way to America, through the agency of the United States Department of Agriculture. In America the value of the sorgho was speedily recognised; it was at once put under very extensive cultivation, and it now forms one of the staple crops of that country.

The Imphee.

6. A short time after the introduction of the Chinese sorgho into France, seeds of another plant very similar to the sorgho were taken to that country by Mr. Leonard Wray. This gentleman, who was by profession a sugar planter, discovered the *Imphee* or *Im-Fé* (sweet reed), as it is called by them, growing around the huts of the

Kaffirs, who cultivated the plant for the purpose of chewing its stalks. Olcott, at pages 19 and 25 of his excellent work on the Sorgho and Imphee, gives the following account of the introduction of the imphee into Europe and America:—

"Curiously enough, there was received in France at about the same time" (as the introduction of sorgho) "a quantity of seeds of a plant having apparently the same properties and almost the same appearance as the sorgho, which had been discovered on the south-east coast of Africa, in the country of the Zulu Kaffirs, by Mr. Leonard Wray.

"The lucid, but truly surprising statements made concerning its virtues by this latter gentleman, at once stimulated in a most lively manner investigations into the properties of the Chinese sugarcane, and upon comparing the plants derived from these widely separate sources, the remarkable fact was made apparent that in ability to yield crystallised sugar, to afford nourishment for stock, and in the requirements of cultivation, and other peculiarities, they were almost identical; and much surprise was created that from this double source, and as if corroborative the one of the other, a greatly needed sugar plant and one apparently of high value should have been given to French agriculture. * * * *

"In 1850 Mr. Wray left the East Indies for the Cape of Good Hope, whence he went to Kaffirland, and found the Zulu Kaffirs cultivating the imphee around their huts, not for the purpose of manufacturing crystallised sugar, or obtaining any other of its products with a commercial view, but merely for the purpose of chewing and sucking the stalks. He quickly saw of what value such plants were likely to become to Europe and America, and applied himself to their study, their culture, and manufacture into sugar, &c. After having fully satisfied himself on these points he returned to Europe, and planted patches in England, France, and Belgium; applied for patents in various countries; addressed the French Government through Marshal Vaillant, Minister of War; exhibited specimens of sugar and the plants to Mr. Buchanan, then American Minister at London; and subsequently established the culture of the imphee in Turkey, Egypt, the West Indies, the Brazils, the Mauritius, Australia, and finally in this country. Instead of one variety as we have of the Chinese Sugar Cane, he has discovered among the Kaffirs no less than sixteen distinct kinds of imphee of various degrees of saccharine richness, and differing very widely in the time required for their maturity. The gift that he has thus made to our agriculture may be estimated when we reflect that we have almost every range of climate known in the world—from the torrid and fervent heats of the tropical zone to the most rigorous winters of the North; and his plants requiring in some instances but ninety days to run through the whole course of vegetation and ripen their seeds, others of greater saccharine richness requiring a more lengthened season than is necessary for the ordinary sugarcane,* he has thus given to the farmers of every section of the country the opportunity to select from out his collection of varieties some one peculiarly adapted to the latitude in which he resides. Sugar by this means, supposing his anticipations to be realised, and the experience of Governor Hammond and other Southern gentlemen to be a presage of what we can anticipate in future, will become no longer even such a luxury as it is at present, but rather will assume its proper position as a cheap, readily obtainable article of common use. * * * * * * * *

"In the year 1856 Mr. Wray obtained the large silver medal of the *Exposition Universelle* at Paris, for his imphee sugar, alcohol, seeds, and plants; and the French Government, moreover, granted to him 2,500 acres of land in Algeria to encourage in that colony the establishment of this important cultivation."

The Sorgho and Imphee.

7. The Chinese sorgho was introduced into the United States in the year 1854, and the African imphee in 1857. The imphee was classed under the same order in Botany as the Chinese sorgho, *viz.*, *Holcus saccharatus*; and it is in point of fact the same plant, there being, however, some differences in it as produced by China and Africa, amongst which are the fact of there being some sixteen varieties of the imphee while there is but one of the Chinese sorgho, and the difference in the height of the plants—the sorgho growing to 19 feet high, while the tallest variety of the imphee does not attain more than 15 feet. There are also other differences between the sorgho and the varieties of the imphee, as in the colour of the seeds, those of the Chinese sorgho being of a dark purplish colour, almost black, while those of the imphee are of all colours from a canary yellow to a dark brown, and red, in the different varieties. Mr. Wray gives a short account of the imphee in a paper which is appended to Olcott's work. In this paper he sets forth the peculiarities of each of his sixteen kinds or varieties, and gives many interesting particulars regarding them. Mr. Wray considered the *Holcus saccharatus* to be the connecting link between the sugarcane (*saccharum officinarum*) and the grain yielding sorghums; and so strongly did he receive this impression, he says, when he first saw the two largest varieties of the

* This is an error. The slowest of the imphees requires but from five to six months to ripen its seed, and the sugarcane takes from twelve to fourteen months, and sometimes longer, to arrive at maturity.—F. G. W.

imphee, that he almost persuaded himself that they were in reality *hybrids* between the sugarcane and the Kaffir corn (*Sorghum vulgare*). This, however, as he says, is not the case.

Botanical history.

8. Some investigations were made in America into the botanical history of sorgho and imphee, and the matter was taken in hand by the United States Department of Agriculture. Mr. F. Pech, a member of the Department, prepared a report on the subject, in which he says that the Chinese sorgho, which he calls the *Indian sugarcane* in contradistinction to the grain-yielding sorghums, which he includes under the term *Indian millet*, originally came from the East Indies, where it is known by the name of *shorghi*. He also affirms that the African imphees are originally descended from the Chinese sorgho, saying that that plant was conveyed to Africa through Asia by Egyptian and Syrian commerce, and from Italy to the North Coast of that Continent. The great similarity between the present Chinese sorgho and the imphees gives good ground for this affirmation, and there is the more reason in it when it is considered that in the opinion of many eminent botanists even the *grain-yielding* and *sweet* sorghums are descended from the same original stock. The "shaloo" and the "black jowar" cultivated in India, are very nearly allied to the sorgho. The relative value of these plants has not been taken into consideration in the experimental cultivation of sorgho in India.

Description of Sorgho.

9. Sorgho very much resembles Indian corn, in appearance as well as in habit and growth. The following description of the Chinese sorgho is taken from Olcott's book:—

"In comparing the appearance of the sorgho with that of our common maize or Indian corn, we are struck with the superiority of the former, in respect to the exceeding grace of appearance which it presents. Like the latter, it presents a tall straight stalk, marked at intervals with knots or nodes, and from these, on alternate sides of the plants, spring long, spreading, tapering, and drooping leaves. The stalk very gradually decreases in diameter from the base to the top. Its outer coating is smooth and silicious, like the stalks of the maize, which becomes harder as the water and starch and the sugar of the plant become converted into woody fibre, and more silex is deposited on the outside. The seed grows upon the eight or ten separate stems which group together to form the tuft at the top of the plant; and, unlike the maize, this is the only fruit produced by the plant. When the tassel first emerges from its sheath the seeds are nothing but a soft green husk, which, by degrees, and in like manner to wheat, becomes filled with farinaceous matter; and the grains are plump and hard. The soft green pulp as the plant approaches maturity undergoes transitions in colour, changing to violet, brown, and finally to a purple, almost black. When this latter colour appears the plant has reached its last stage of vegetation, and will give its greatest amount of sugar. The stalk, as compared with that of the maize, is more slender and soft. The adhesion of the parts above and below the knots is not so firm, for I have found in the crops which we have cultivated at the farm school, that a gust of wind would break the plants off at the knots when they attained considerable height, in a wet season. Another peculiarity distinguishing the sorgho stalk from that of the corn, is, that as the plant approaches maturity, we see a whitish efflorescence appear upon the parts underneath the foot-stalks of the leaf. This is a dry, hard powder, and is known to the French under the name of *Cerosie*, or vegetable wax."

Height.

10. Sorgho attains different heights according to the circumstances attending its growth. In some soils—deep black loam, for instance—the Chinese sorgho grows to the great height of 18 and 19 feet. On other soils, and under less favourable conditions, the height varies from 6 to 12 feet. The height of the Chinese sorgho, with its slenderness, has, in fact, been found an objection to the plant in the United States, as with a strong wind the plants are liable to be blown down; and it is said that they sometimes even fall of their own weight when grown to their full height. The Chinese sorgho sends up 8 or 10, and sometimes even more stems from one seed; and some varieties of the imphee, according to Mr. Wray, throw out as many as from 15 to 20 stems. The several varieties of the imphee grow to different heights varying from 6 to 16 feet.

Reproductive power.

Sorgho possesses the property of rattooning. It will send up a second growth if cut down when from three to four feet high and before the seeds have matured, and even a third growth of good plants will spring up if the weather be warm enough. In all tropical countries the plant becomes a perennial.

Value of sorgho.

11. Sorgho is a plant of high value, producing, as it does, sugar and alcohol from the stalks, while the leaves and stalks, either in a green or dry state, make most excellent food for cattle. Regarding the sugar and the forage more will be said further on. The alcoholization of the juice of the sorgho is a fully established fact, and alcohol, with vinegar, spirits, wine, and beer resulting from it are among the chief products of sorgho, this property having been largely utilised in the United States of America, France, and Algeria. The seed, also, has its several uses. It is very nutritious. All kinds of stock and poultry devour it greedily; when they have once become accustomed to it, which it is believed they readily do; it has been much used for fattening pigs and poultry, and it has even been given to horses in place of oats, with good results. It also furnishes a very good flour, which makes an excellent bread. This flour, however, has a violet tint running through it, which comes from the hull of the seed, and this is the principal reason why sorgho bread, although said to be very palatable, is not popular. Bread and cakes, indeed, made from this flour in the United States have been pronounced to be second only to those made from wheat flour.

Alcoholic properties of the juice.

Nutritive properties of the seed.

The seeds of sorgho contain a starch of good quality. This starch, however, unless its extraction from the seed is very carefully performed, is always more or less tinged with the colouring matter which abounds in the seed.

The dye contained in the seed.

12. The colouring principle contained in the seed is valuable as a dye. Many successful experiments have been made, both in France and America, in extracting this dye and applying it to ribbons and cloths, and great hopes, which do not, however, appear to have been realised, were entertained of the dye coming largely into general use. Dr. Henri Erni, the Chemist of the Department of Agriculture, United States, gave the following account of an experiment made by him in the year 1864 in extracting the colouring matter from the seed and employing it as a dye:—

"The simplest solvent is alcohol, but this being now a most expensive article ($5 per gallon), diluted acids were resorted to with very good success, and at an expense and trouble hardly worth mentioning. The seeds were boiled in vinegar, or in water, to which oil of vitriol has been added before heating, until the mixture tastes as acid as vinegar; other acids, such as tartaric, oxalic, &c., can be used, but are more expensive. When the liquid assumes a red, or rather an intense orange colour, it is ready for use. The articles to be coloured are at once brought into the hot solution and agitated until the colour no longer increases. They are at once removed and dipped into a weak solution of salt of tin (chloride of tin) obtained by dissolving tin in hydrochloric acid. They are then exposed to the air for a short time and washed. Cotton and silk may thus be coloured red; wool turns to a beautiful purple, and an almost unlimited variety of colours and shades may be obtained by substituting for salts of tin other mordants. All the various shades of red, purple, grey, orange, &c., are thus produced from the same bath, the cloths being afterwards drawn through solutions of protochloride of tin, bi-chromate of potassa, sulphate of copper, ammonia, lime water, sub-nitrate of bismuth, &c., &c. Yellow is produced by adding to the seed sufficient nitric acid to form a thick mushy mass. Too much acid will make a straw colour. This dye turns solid by standing, and may thus be stored. To dye silk or wool yellow the solid dye is dissolved in boiling water, the goods dipped into it, and afterwards washed. Cotton has the least attraction for sorghum dyes, while wool receives the brightest colours."

Richness of the dye.

13. The colouring principle in the seed is so rich that it discolours the dung of cattle and poultry fed on the seed, and it has been known even to discolour the flesh and bones of poultry. The colouring matter is, however, entirely without taste, and does not in any way affect the health of poultry or of animals fed on it, or the quality of their flesh for eating.

Dye also contained in the stalks.

14. The same dye is also developed in the stalks, after the juice has been pressed out of them. The following is a method of preparing it, given in the Report of the Commissioner of Agriculture for the year 1862, page 535:—

"The pressed canes are left to ferment in heaps until the colour changes to a red or reddish brown. They are then cut up, dried, and washed. The colour is extracted by a weak dye of caustic potash. By neutralising the alkaline solution by a weak solution of oil of vitriol, the colour falls in the form of red flakes, which are easily soluble in alcohol, alkalies, and diluted acids."

15. A crop of sorgho can be utilised in various ways: there need not be a particle of waste. In sugar or syrup-making, the scum that rises to the surface during the process of boiling the juice is valuable for fattening stock. The first scum that rises may be used for this purpose, but from the later scums vinegar or brandy of excellent quality may be made. Vinegar can be made in the proportion of one to three of the bulk of the juice that is being boiled, and brandy in the proportion of 1 to 10. The canes, after the juice has been crushed out of them, have their value for different purposes. There is the dye, already mentioned, that can be extracted from them, and they can be used for feeding cattle, which eat them readily. They are also useful for making paper. There were in Illinois in the United States, in 1862, two mills which had been established for the sole purpose of manufacturing paper from these canes, and large quantities of paper have been made. There is an account of a Frenchman at Turin making vinegar by watering the crushed canes with juice of the sorgho. These crushed canes have, besides, their value as fuel and manure, for which purposes they are used in the United States in connection with sorgho-growing and syrup-making. The canes make an excellent article of fuel, giving forth a good strong flame which is of great use in boiling the juice, and they have been found to be an excellent means of fertilising the soil for a new crop of sorgho.

The refuse in sugar-making valuable.

The crushed canes.

16. The *cerosie*, or vegetable wax, found on the leaves of the plants, is another product of the sorgho. It is similar in its composition to bees' wax, and its value per acre has been computed at 36 dollars, to be added to the other profits given by the cultivation of sorgho. This wax, however, cannot be made use of, at least in Europe, and where European labour only is available, on account of the trouble of collecting it.

The cerosie.

17. All the above uses arising out of the properties of sorgho are well established, and have been largely turned to account, with the exception of the *cerosie*, the starch, and the dye, neither of which products can be obtained from the plants without considerable trouble and expense incommensurate to their value. The great value of sorgho, however, is as a syrup, alcohol, forage, and grain-yielding plant, and particularly as a forage plant, and it is now under cultivation for these products in the United States of America, in Algeria, France, Australia, and other countries.

The uses of Sorgho.

18. A brief review of the cultivation, condition, and prospects of sorgho in the United States of America, where the plant has received most attention, may prove of interest, and will now be given. The following experience of the sorgho and imphee as sugar plants since their introduction into the United States is recorded by the Chemist of the Department of Agriculture, United States, in the first yearly report of the Department, *viz.*, for the year 1862 :—

Cultivation in America.

"In the United States the question of the new sugarcane, before the rebellion, received considerable attention, both from the Government and from private individuals. In the Patent Office Agricultural Reports from 1854 to 1861, and in the present Report of the Department of Agriculture, there are several articles from scientific and practical men, by which the progress in our sorghum experience may be followed. Drs. Jackson, Hayes, and Lawrence Smith have there examined the subject chemically, while several farmers have recorded their valuable practical experience upon the culture of the canes and yield of syrup. Whoever may desire to possess the information upon this subject in a connected form may do so by means of the excellent work upon sorgho and imphee by Henry S. Olcott. The increase of prosperity and population due to a continued peace, together with the gradual relative decline of the beet-sugar manufacture in France since the dynasty of Louis Philippe, with other causes, affected the relations of sugar supply and demand in such a manner as to concentrate much attention upon the new canes everywhere. Upon this came the rebellion to intensify, in the United States, this attention. Extensive areas in different sections of the Northern States were planted; machinery was procured for crushing the cane and boiling down the juice; conventions of sorghum planters and sugar manufacturers were held; and newspapers, devoted to the specialty of the new canes, were established. In the West the interest taken in the sorghum question has been especially great. In this section of our country* the demand for molasses has always

* Washington.

been large, and the farmers, observing in the new cane a means of supplying this demand by their individual labour, did not hesitate to plant largely. Letters received by the Department state that in the localities of the writers the wholesale grocers purchased no sugarcane molasses last fall."

The Commissioner of Agriculture, in his minute preceding the Report of his Department for the year 1864, says,—

"The introduction of sorghum and imphee, and the dissemination of the seed of these plants by the Agricultural Department, has been worth millions of dollars to the country, more especially to the Middle and Western States, where they are destined to make a valuable and paying crop.

"The manufacture of large quantities of beautiful sugar has proved that what was at first regarded as a doubtful experiment has become a fixed and most important fact, and although sugar may not be everywhere made, there is scarcely a State where large quantities of most excellent syrup are not manufactured. The seed of these plants has, however, so much deteriorated by hybridizing with our broom corn, that I have deemed it of great importance to procure fresh seeds from their native localities, and have accordingly sent an educated, intelligent, and reliable person to China, with directions to purchase seed, and to ascertain minutely the method of making the sugar as practised by the natives of that country."

An examination in the following year of syrup produced from plants raised from this new seed produced highly satisfactory results, and the seed obtained from them was afterwards widely planted. The Commissioner of Agriculture does not appear, however, to have obtained any information regarding the condition of sorgho in China, or any particulars regarding its cultivation; and on this subject very little is, indeed, known. This want of knowledge has been a great impediment to the successful cultivation of the plant.

Condition in 1860 and 1862.

19. The yield of syrup from sorgho in the year 1862, and the acreage under the crop, in ten of the principal States in which it was grown, was as follows:—

	Acreage.	Gallons of syrup produced.	Gallons per acre.	Value of crop.
				$
Illinois	11,148	1,594,192	143	601,444
Indiana	8,011	1,241,665	155	595,999
Iowa	27,006	3,996,948	148	1,598,779
Kansas	1,067	158,964	149	81,071
Michigan	2,913	533,018	183	303,820
Minnesota	248	29,984	125	18,568
Ohio	49,883	6,484,800	130	3,566,649
Missouri	10,631	1,552,202	146	667,447
Pennsylvania	122	19,210	158	11,526
Wisconsin	308	38,516	125	22,725
TOTAL	111,337	15,649,499	146	7,468,028

There are no data available for the other States for this year, but the yield of molasses in 1860, only two years previously, from all the sorgho-producing States, *viz.*, the above ten and sixteen others, was less than half this amount, having been 7,176,042 gallons. Of this quantity the production of the ten principal States mentioned above was 5,491,687 gallons.

Failure as a sugar crop, and decline in the cultivation.

20. Sugar had been made from sorgho, up to this period, but not in sufficiently large quanties to enter materially into the trade of the country; it was, however, fully expected that sorgho would come into general cultivation as a sugar crop. But this has not been the case. Sugar could be made (and was made in large quantities) by a few only, and the cultivation of the crop gradually declined from about the year 1865, the farmers giving up the cultivation on finding that a crop of plants did not mean in every case a crop of sugar. The introduction of sorgho into the United States, and the brilliancy of the accounts given of it, created immense excitement; and every farmer was anxious to cultivate sorgho and raise his own sugar from the crop. Many succeeded in obtaining satisfactory results, but many, on the other hand, failed, and naturally; for in most cases, as is frequently asserted in the reports on the subject, the farmers expected too much, hoping from a few square yards of land and with very primitive machinery to obtain without fail a crop of sugar from the new canes. The manufacture of sugar from sorgho requires, it has been said, quite as

Cause of failure.

much care and skill as the manufacture from the ordinary cane or the beet, the superiority of sorgho over these plants, as a sugar-producer, consisting merely in the short period of time required for its coming to maturity, and in its comparatively easier culture; and the great mistake made appears to have been the notion that sorgho was to furnish a royal road to sugar-making. Sorgho has, it should at the same time be said, other secondary advantages over these crops, as in the superior value of its refuse in sugar-making for forage, alcohol, and other purposes.

Still, however, largely cultivated.

21. It may be said that sorgho during the first decade of its existence in America did not receive a fair trial. Its cultivation was given up by many, as has been said, on the failure of their plans for sugar-making during this period, but although there has been a gradual decline in the cultivation for sugar, the crop has to a certain extent held its own as a good producer of the substitute, molasses; and it has continued to be ranked amongst the principal crops of the United States as a producer of molasses, alcohol, and forage. The decreased interest taken in sorgho, however, by no means proved the incapacity of the crop to yield profits from cultivation for sugar, as the success which always attended the efforts of some growers in the United States who persevered in the growing and manufacture very clearly shewed.

Sorgho in Michigan;

In the State of Michigan 800,000 gallons of sorgho molasses were made during the year 1866, and the sorgho interest was then fast increasing in the State. In 1867, although the cultivation of the crop was steadily on the increase, the yield was much diminished, having been 400,000 gallons only, on account of the badness of the season. The quality of the syrup was, however, said to be improving annually, and in the year 1871 reports were received from certain sorgho-growers giving the most satisfactory accounts of their cultivation of sorgho.

In Iowa;

22. The following figures, given in a report furnished by the State of Iowa in the year 1868, shew the area under sorgho and the produce of syrup in the State during the four years specified, *viz.*,—

	Acreage.	Gallons.	Gallons per acre.
1858	5,606	410,776	74
1862	* 37,607	3,442,396	96
1864	21,452	1,543,604	67
1866	25,796	2,090,557	81

The product in 1867 was said to be about 3,000,000 gallons. The amount of sugar made was, in 1862, 21,469 lbs., or 1 lb. to every 140 gallons of syrup made; in 1864, 8,386 lbs., or 1 lb. to every 172 gallons of syrup; and in 1866, 14,697 lbs., or 1 lb. to every 143 gallons of syrup made.

The reports for the years 1872 and 1873 stated that increasing interest was manifested in the cultivation of sorgho in the State; that 34 counties had reported a crop averaging from 100 to 300 gallons per acre during the year 1871; that the area under the crop in 1871 was 40,000 acres; and that the yield of syrup from the crop of 1870 was 2,979,480 gallons, and of sugar 16,500 lbs. The yield of syrup for the year 1872 was estimated at 3,500,000 gallons. The cost of cultivating and manufacturing sorgho in the State was given at $39, and, placing the syrup at the low estimate of 50 cents per gallon, and the yield at 100 gallons per acre, which was regarded as a very moderate estimate, a profit was left of $11 per acre. One farmer, who had given much careful attention to the manufacture of sorgho sugar, and who had made large quantities of sugar in three or four successive years, raised sorgho at the rate of 305 gallons of syrup per acre. The cost of cultivation and manufacture was $70, and the syrup selling at 50 cents per gallon gave him a clear profit of $82·50 per acre.

In Wisconsin;

23. The product of syrup in the State of Wisconsin in the year 1866 was valued at half a million dollars.

* These figures differ slightly from those given on the preceding page.

24. The following information regarding sorgho in the Southern States is extracted from the report of the United States Agricultural Department for the year 1871:—

In the Southern States.

"With regard to sorgho in the Southern States, Major Wall, in his Manual of Agriculture for 1870, says that the sorghum thrives with great luxuriance in the rich bottom lands or in moist, loamy soils, well manured; endures cold and drought much better than corn, and resists without injury slight frosts in the fall; in Virginia and other Southern States it seeds in October when planted by the 20th of June. At the extreme south it may be planted from January to July. He states that the height attained varies from 6 to 18 feet in the Southern States. He estimates the weight of the crop of cane at ten to forty tons per acre; the seed produced at 15 to 16 bushels; yield of juice from well-trimmed stalks, 50 per cent.; gallons of juice to a gallon of syrup, 5 to 10; yield of syrup per acre, 100 to 400 gallons; yield of alcohol, 5 to 9 per cent. He refers to the value of sorghum for cattle forage, and states that a capital bread can be made of flour from the seed."

25. The Statistician of the Department of Agriculture, in the Annual Report of the Department for 1873 (which is the latest one available), said that the experimental culture of sorgho as a sugar plant had been very satisfactory in many portions of the country, the seeds having been widely distributed by the Department of Agriculture; and that the census of 1870 shewed a manufacture of 16,050,089 gallons of molasses and 28 hogsheads of sugar. These results, he remarked, were very small in comparison with the great public necessities which the sugar interest is expected to supply, and he observed that reports from correspondents did not give any ground for hoping that sorgho would ever be a source of sugar supply, or that even its molasses product would rise to any commanding importance; but, "on the contrary, the industry appears to be declining in some localities where its early prosecution was considered very promising."

Prospects in 1873.

26. This is the effect of the want of perseverance so often referred to in the earlier reports; and sugar is only obtainable from the sorgho by making use of the best methods known, and by the exercise of a very careful attention to all the details of the process. The different processes necessary for the realisation of crystallised sugar must, however, be so exact in every step, from the selection of the seed to the final striking of the crystals, that it is perhaps scarcely to be wondered at that but comparatively few farmers succeeded in obtaining satisfactory results in sugar-making. The increased supply of sugar from other sources, especially from the sugarcane of Louisiana,—the product of sugar from that State having gradually increased from 6,668 hogsheads in 1864 to 108,520 hogsheads in 1872,—had great effect in reducing the interest taken in the cultivation of sorgho. Indeed, the best days of sorgho in the United States were during the American war, when there was scarcely any sugar produced in the State of Louisiana, the number of hogsheads made having fallen from 459,410 in 1861 to 6,668 in 1864, scarcely any sugar being made during the intervening years. It was at this period that the valuable properties of the sorgho were most largely turned to account, the produce of the crop forming a most welcome substitute for the saccharine supply of the Gulf Straits; but as the prices of southern and foreign sugar declined, sorgho became neglected, being unable to compete, under the disadvantages from which it laboured, with the sugarcane of the south.

The real difficulties in sugar-making, and chief causes of the falling off in the cultivation.

27. To sum up, the sorgho and imphee plants, although they have been of immense value to the Americans, have nevertheless failed to realise the great expectations formed of their becoming, in conjunction with the sugarcane and the beet, the sugar plants of the United States. They have, however, in some degree lessened the necessity of the import of molasses; and, after the various experiments that have been made, and the amount of sugar and molasses that has been extracted from the sorgho and imphee in the United States, there is no doubt left that these plants are very rich in saccharine matter, and that there is a large amount, sufficient at least to compensate the labour of extracting it, of crystallised sugar contained in them. A great difficulty in the way of extensive sugar-making from sorgho at first was the uncertain composition of the juices obtained from different varieties of the cane, which made it of the first importance to procure the right kind of cane for this particular purpose. Another hindrance to the manufacture

The result of sorgho cultivation in America.

of sugar was the discovery that the ordinary processes in use in Louisiana for extracting sugar from the sugarcane were not adapted to the sorgho. The best methods of manufacturing sugar from the *Otaheitan* variety of the imphee, and syrup from the Chinese sorgho, which are acknowledged to be the best of all the varieties for these respective purposes, are, however, now sufficiently well known to the Americans, and it has been admitted that there are no substantial reasons for the crop not having continued to be one of general cultivation, for sugar as well as for molasses, in the United States.

Future prospects of sorgho as a sugar crop in the United States.

28. The introduction of sorgho into the United States has been compared to the introduction of the sugarcane. The difficulties to be overcome in the manufacture of sugar in the one case are probably as great as they were in the other, and judging from the official reports on the subject, it is perhaps not too much to expect that there may yet be a future for sorgho in the United States as a producer of crystallised sugar. Over 90 millions of dollars' worth of sugar, molasses, &c., is annually imported into the United States; and as the demand for sugar from foreign sources is likely to increase every year, there is a great need of sugar plants, which the beet, and perhaps the sorgho, may be expected in course of time, to a certain extent at least, to supply. The supply of sugar from the maple, although large, is considered likely to fall off, as the number of maple trees in the United States is said to be decreasing yearly; but even if this were not the case, putting aside the question of maple sugar, there is still a large field for the manufacture of sugar from other plants in the United States; and in latitudes where the sugarcane ceases to grow, the sorgho and the beet, when the best processes for the conversion of their juices into sugar shall have become more generally known and understood, may enter into rotation. The extensive manufacture of sugar from the beet, which is such a prolific source of sugar in Europe, is still an unsolved problem in the United States, although the industry is on the increase and will, doubtless, eventually become a great one; and as regards sorgho, the practical results obtained by many farmers in the United States, to say nothing of the results of analyses, prove, as has already been said, that large quantities of crystallised sugar are contained in sorgho, and that the plant is a most valuable one as a sugar-producer; and the experience gained by many in the United States in the peculiar properties of its juice, and in the best methods of converting it into sugar, as well as their knowledge of the habits of the plant and the best methods of cultivating it, may yet form the basis of renewed operations in the direction of sugar-making from sorgho.

Present condition.

29. The extent of the cultivation of the crop in the United States is much less now than it has been, and there does not appear to be any immediate prospect of the cultivation extending. The latest reports from some States, indeed, shew that the cultivation is still further on the decline. Molasses chiefly, with alcohol, forage, and seed, are the products for which sorgho is now grown in America.

The latest available reports shew the average yield of molasses to an acre during 1873, in all the States of the Union (23 in number) where sorgho is grown, to have been 89 gallons, selling at an average price of 59 cents per gallon. In the State of Florida, which shews the best average, the yield averaged 200 gallons of molasses per acre, selling at 50 cents; and in the State of Mississippi the yield averaged 113 gallons per acre selling as high as 71 cents per gallon.

Value of sorgho as a forage plant.

30. Wherever sorgho may be grown, and for whichever of its products in particular, it always has its value as an excellent and most nourishing fodder for horses, cows, hogs, sheep, and cattle of all kinds. The excellence of sorgho as a forage plant is quite undisputed. It is largely used, in the United States of America and elsewhere, for fodder; and its extraordinary nourishing qualities are admitted on all sides. The accounts of farmers and others in the United States, as well as in France, regarding the value of the sorgho and imphee,—seeds as well as leaves and stalks,—for fodder, are very numerous, and all tend to the same conclusion, *viz.*, that the crop is well worth cultivating and repays cultivation most advantageously if grown simply as fodder for stock, and none of its other products are used. The saccharine richness of the plant makes it especially

valuable for feeding milch cows, their milk being very much enriched, the quantity at the same time being enhanced by its use. The following is an extract from the United States Patent Office Report for 1855 on this subject:—

"Aside from other economical uses, its value for feeding to animals alone, in every section of the Union where it will thrive, cannot be surpassed by any other crop, as a greater amount of nutritious fodder cannot be obtained so cheaply in a given space, within so short a time; and without wishing to present the question in an extravagant light, it may be stated that this crop is susceptible of being cultivated within the territory of the United States to an extent equal to that of Indian corn, say 25,000,000 acres per annum; and estimating the average yield of dry or cured fodder to the acre at 2 tons, the yearly amount produced would be 50,000,000 tons, which, to keep within bounds, would be worth at least 500,000,000 dollars, besides the profits derived from the animals in milk, flesh, labour, and wool."

Yield of forage.

The yield of green forage to an acre of sorgho in the United States is from 7 to 40 tons, and of the fodder, when dried, from 2 to 9 tons. In Algeria, where the climate is peculiarly adapted to the growth of the sorgho, the yield of dry fodder to the acre has been as high as 10 tons. The yield of seed, which is used as grain for cattle in the United States, is from 25 to 50 bushels (of about 36 lbs. each) to the acre; and in the south of France, where the sorgho grows very luxuriantly, the yield has been as high as 60 bushels (2,160 lbs.) to the acre.

Yield of seed.

Culture.

31. In America it is found that sorgho will grow and thrive anywhere and on any soil where a crop of Indian corn can be raised. The sorgho is a slow grower at first, the seeds taking from 10 to 15 days to come through the ground; and the young plants look weak and sickly and make but very slow progress for some weeks after they appear above the surface. This fact is likely to discourage cultivators who are unacquainted with the habits of the plant, and to cause it to be neglected, but nothing need be feared so long as the young plants have an ordinary amount of care bestowed upon them; and they are remarkably hardy afterwards. The plant is very easy of cultivation: all the care that it requires is during the early stages of its growth, when the young plants must be well hoed. They may, too, be hoed ever so roughly, their hardiness securing them from much injury on this account, but they must not be altogether neglected; and all the additional care bestowed on the crop during its early stages is amply repaid in the yield. The plants after about the first month of their growth are very hardy, and stand drought well, recovering after rain although they should have been almost killed by the drought. This is one of the strong points of the crop in the United States. Sorgho has there been grown successfully in parts where drought is excessive. The plants stand the effects of frost, too, exceedingly well; and they have frequently been known to withstand frosts that have killed Indian corn growing beside them. Nor are the plants when young materially injured by being frost-bitten; if the dead part is removed the rest springs up well and thrives.

Hardiness of sorgho.

Ploughing.

Soaking the seed.

32. Sorgho is a remarkably deep-rooted plant. Its roots have been traced down as far as four, and even eight feet deep, and subsoil ploughing is consequently a great advantage in cultivation. It is well to soak the seed in tepid water for 24 hours before planting, in order to assist germination, the hull of the seed being very hard. Some days may be saved by this means, and this will give an advantage over the weeds. Soaking is also useful in being a means of separating the good seed from the bad. Care should be taken, in sowing, to cover the seed lightly, as if sown deep it is liable to rot in the ground. In America the seed is sown in April or May, and it has been found that a light, sandy, calcareous soil is best suited to the plant when grown for sugar or syrup. When the crop is grown for syrup the seed is sown in drills, and the young plants afterwards thinned out, the extent of this thinning being usually determined upon by the richness of the soil and its capacity for supporting the growth of a large or small number of canes. The young canes bear transplanting very well, and it is found advantageous to transplant in latitudes where cane cannot be matured from the seed direct. Transplanting is practised in China.

Sowing.

Transplanting.

33. Sorgho being nearly related to the broom corn, Guinea corn, and doura or Egyptian millet, hybridizes very freely with any of these; and it must not, therefore, be allowed to grow near them, or hybridization, with a consequent diminution of the saccharine properties of the plant, would certainly take place. The only course to adopt when this occurs is to change the seed; indeed, if syrup or sugar is to be made, it should always be the first care of the planter to procure a fresh stock of seed for sowing, unless the plants of his previous crop have been in every way good and all that could be desired. The selection of the seed is a very important matter in syrup-making, and this is one of those points which make care such an object in sugar-making from sorgho, there being so many varieties of the imphee that contain but a small quantity of sugar, while in a hybridization between the Chinese sorgho or the imphee and any of the grosser sorghums, there would probably be little or no sugar at all.

Hybridization.

34. Of the uses to which sorgho is put by the Chinese, the chief is the chewing of the stalks for the sake of their juice. They make use of the colouring matter contained in the seeds as a dye, and also of the *Cerosie* which they obtain from the leaves. Of this wax, mixed with tallow, they make candles, which burn well and give a clear, brilliant light. Sugar is made in small quantities. Dr. Balfour, in his Cyclopædia of India, says that sorgho is not much cultivated in China, and he says that the plant is there propagated by cuttings as well as by seeds. Sorgho is cultivated by the Japanese, who make from it sugar, and alcohol; and the plant is much valued by the Chinese Tartars. Some stalks of the sorgho, under the title *Précieux Gaoutlam de la Chine*, were exhibited at the Great Exposition at Moscow in the year 1852.

Uses of sorgho in China.

In Africa, the Kaffirs do not make any use of the imphees beyond chewing the stalks. They always take the seeds from their plants before they have ripened, thinking by so doing to retain in the stems the richness that goes into the seed; but this idea is very generally believed to be an erroneous one, and as the seeds are valuable, it is always best to let them mature for their own sake, while the benefit to be derived from their removal is doubtful, the plants usually to some extent exhausting themselves by throwing up new tops to replace those that they have lost. No use is ever made of the seeds, except for sowing, the Kaffirs believing them to be unfit for human food; but here again they have been proved to be in the wrong, and flour of superior quality has frequently been made from the seed of the imphee in America and other places where the plant has been cultivated.

In Africa.

35. An attempt was made about the year 1766 to introduce the imphee into Europe. Professor Arduino, of Florence, published an account of his experiments in extracting sugar from the plant. His experiments turned out well, but it is believed that he did not possess the particular variety of plant best suited to the climate of Italy, and that this is the reason of the plant having been altogether lost sight of in Europe until it was re-introduced by Mr. Wray. Mr. Wray says, as indeed do all writers on the subject, that the selection of the variety best suited for cultivation in particular latitudes is of the greatest importance to the successful manufacture of sugar from the imphee.

The imphee introduced into Europe in the year 1766.

SECTION II.

SORGHO IN INDIA.

36. The first introduction of sorgho into India dates as far back as the year 1858, when the Madras Government, at the instance of Dr. Balfour, who was then in charge of the Government Central Museum, obtained a supply of imphee seed from the Cape of Good Hope, and also a small quantity of seed of the Chinese sorgho from America. This seed was very widely distributed amongst the several agricultural societies, to district officers and others, all over India, as well as to a few private gentlemen in the Madras Presidency, for experiment with a view to determine the value of the sorgho both as a sugar and forage plant.

Introduction in the year 1858.

Results of the first experiments made.

The results of these first experiments were various in different parts of the country, but tended generally to shew that wherever the seed was good when it was sown, and proper care was exercised as to the time of sowing, the plants would grow well and the crop prove a profitable one; and the general opinion formed of sorgho was, that although it was not to be compared with the ordinary sugarcane of the country as a sugar producer, it would prove valuable as a forage plant.

37. In the Madras Presidency the experiments,—which were chiefly with the African imphee,—were continued up to the end of the year 1863, and with good results, several experiments being made at different seasons in each district of the Presidency, when the conclusion arrived at by the Board of Revenue at Madras was as follows:—

"The cultivation of imphee in this country is no longer a doubtful experiment. The plant grows freely whenever cultivated with ordinary judgment and care. It certainly will not take the place of sugarcane, and it may be doubted whether it will pay as an irrigated crop, but it affords excellent forage for horses and cattle, and may be cut three times for each sowing. It is of rapid growth, and should be sown in the first rains, so that the third growth may derive advantage from the latest rains, and a good seed be obtained for re-sowing."

And further, on some later failures to make sugar from the juice being reported, that "the value of the plant is as fodder for cattle, or as a cereal; that it is a mistake to suppose that it is valuable as a sugar-producing plant; and that, without attaching any very great value to the imphee plant in the Madras Presidency, except for forage, the Board see no reason whatever to suppose that it will not grow well in every district if fairly tried."

Discontinuance of the experiments.

38. The experiments at this point seem to have been given up entirely. They were only made at the instance of the Government, and the natives generally, after making them, and seeing the good results obtained by European experimenters, paid no further attention to the plant. It was reported from one of the Madras districts (Coimbatore), that the imphee had, with the exception of the head, very much the same appearance as the cholum (jowar) which is so extensively cultivated in the Presidency, and that it was considered by the ryots to be a variety of cholum, and was called by them "sugar-cholum." Reports of a similar character were received from other districts, and it was thought that these facts would favour the introduction of the imphee into the Madras Presidency; but the natives still continued to cultivate their cholum for forage in preference to it, notwithstanding that the imphee was proved to be so valuable as a forage crop. The general inferiority of the imphee as a grain-yielder had apparently something to do with this, the ryots getting both grain and fodder in tolerable quantities from the cholum, while with the imphee, a large yield of fodder is usually accompanied by a small yield of grain. Some private gentlemen who made experiments with the imphee, and who took an especial interest in the cultivation of the plant, formed a high opinion of it. One of these gentlemen, Mr. Kohloff, to whose opinion much weight was attached, thought that the imphee would be likely to thrive in the Tanjore district, where he cultivated it, and that it would be a valuable addition to its cereals, as, unlike the cholum, it throws out several ears at a time and yields a second crop. He added that the stalks of the imphee were not so dry and hard as those of the cholum, and that bullocks that were accustomed to be fed with straw ate them with avidity, while they refused cholum stalks.

Later experiments on the Madras Government Farms.

39. The Agri-Horticultural Society at Madras has been regularly importing seed of the Chinese sorgho since 1858, the year of the introduction of the plant, and sorgho has been under cultivation in the Presidency to a small extent ever since; but since the cessation in 1863 of the special experiments conducted by direction of the Government, the only regular experiments made appear to have been those at the Government farms. Some interesting experiments with the Chinese sorgho have been made on the Sydapet farms, which prove the value of this plant both as a forage and grain yielder. The first of these experiments was made in 1870, when the value of sorgho under different kinds of manure

was tested. Mr. W. R. Robertson, the Superintendent of the farm, reported on this experiment as follows:—

"*Chinese sugarcane.*—This is the true *sorghum saccharatum;* it is a millet, and in habit of growth and in general appearance resembles the cholum of this country. The seed was obtained from Sydney. The soil, having been cultivated as for cholum, was sown on the 10th October 1870. The total area of the piece of land selected was 3,484 yards, and the seed used weighed ten pounds. The seed was sown in drills about two feet apart; it germinated very slowly, and took at least double the time required by cholum in coming through the ground. However, the crop was regular and the plants healthy. When about four inches in height a portion of ground was divided into plots, each containing one-eighteenth of an acre, and different manural top-dressings were applied. The Peruvian guano used was an inferior sample; it contained a very small percentage of ammoniacal salts. The other manures were such as are procurable in this district, and the prices charged are the prices actually paid. The carbonate of lime was powdered shell chunam. All the applications were reduced to a powder before being used; they were all mixed with sand, in order that they should be equally distributed over the ground. A quiet morning was selected for sowing the manure; a drill cultivator followed immediately behind the sower and covered the manure. The crop was grown entirely under dry cultivation; it grew well and had at all times a promising appearance.

"The drill cultivator was passed two or three times through the crop during its early growth, and this was all the cultivation it received.

"In their early growth the canes contained very little more sugar than ordinary cholum. The quantity of saccharine matter was greatest at the time when the seed began to harden. It is at this stage that it is usual in America to cut down the crop for the purpose of extracting the sugar. Harvesting commenced on the 25th January."

The ground on which this experiment was made was divided into twelve plots, two being unmanured, and the other ten manured with five different kinds of manure, each manure being applied to two different plots. The following is an abstract of the results obtained:—

Average results on one-eighteenth of an acre.

Manure.	Yield.		Increase due to manure.	
	Grain.	Straw.	Grain.	Straw.
	lbs.	lbs.	lbs.	lbs.
Unmanured	60 (per acre 1,080)	908 (per acre 16,344)	... ...	... ...
13 lbs. of guano	90 („ 1,620)	1,064 („ 19,152)	30 (per acre 540)	156 (per acre 2,808)
152 „ of carbonate of lime ...	99 („ 1,782)	1,237 („ 22,266)	39 („ 702)	329 („ 5,922)
10 „ of saltpetre	110 („ 1,980)	1,318 („ 23,724)	51 („ 918)	410 („ 7,380)
37 „ of bone-dust	108 („ 1,944)	1,328 („ 23,904)	48 („ 864)	420 („ 7,560)
112 „ of sulphate of lime ...	96 („ 1,728)	1,181 („ 21,258)	36 („ 648)	173 („ 3,114)
Average per acre on the whole sowing ... ... lbs.	... 1,689	... 21,108	... 734	... 5,357

The following table shews the financial results per acre of each manural application:—

Rs. 18 per acre expended on—	Increase due to manure.		Value of increase per acre.	Profit.
	Grain.	Straw.		
	lbs.	lbs.	Rs. A. P.	Rs. A. P.
Guano	540	2,808	24 4 3	6 4 3
Carbonate of lime	702	5,922	36 9 10	18 9 10
Saltpetre	900	7,380	46 7 6	28 7 6
Bone-dust	864	7,560	45 8 3	27 8 3
Sulphate of lime	648	4,914	32 9 1	14 9 1

Mr. Robertson continued:—

"In the above calculations the straw was valued at Rs. 5 per ton, a low price; and the grain at the rate of thirty pounds per rupee, also a very low price. We bought the seed in Sydney last season at the rate of four pounds per rupee, the usual price in Australia for this seed; and our sample is much superior.

"It is gratifying to find that saltpetre (nitrate of potash), an indigenous product, has given the best results; an expenditure of Rs. 18 per acre on this manure having not only nearly doubled the crop, but, after repaying its own cost, left an additional farmer's profit of nearly Rs. 30 per acre. The value of saltpetre has long been recognised in England, but its great cost in that country has prevented its general use. Nitrogen is always more acceptable to plants in the form of nitrate than in ammonia. Nitrate of soda is very largely used in England, and so also would nitrate of potash (saltpetre) be much used if it could be obtained at the price at which most farmers in this country can procure it. This salt is best applied as a top-dressing when the crop is a few inches above the ground; 100 pounds, or at most 150 pounds per acre, is enough to apply; it should always be mixed with an equal volume of sand or some similar material, in order that it may be more regularly distributed over the ground. Bone-dust stands second in my list; probably, if the continued effects of each be considered, it should stand first. Next comes carbonate of lime (chunam). An expenditure of Rs. 18 on lime was not only repaid by the increase in the crop, but a profit of nearly Rs. 20 was added. Sulphate of lime (gypsum) comes next; this also not only repaid its original cost but left an additional profit of nearly Rs. 15 per acre. The guano repaid its cost, but only left a profit of about Rs. 6 per acre. As I have already stated, the guano was inferior; still, I think, there are other reasons for the small return it gave. I use the word "small" return merely in connection with the foregoing results. A surplus of Rs. 6 per acre over the cost of manure is far from being an unsatisfactory profit. Until I have made further experiments I would not like to speak with any degree of certainty; still I am much inclined to believe that the nitrogen, presented as it would be in the form of ammonia, was of very little value to the plant, and that whatever efficacy the guano possessed must be attributed to its phosphates and potash. It must not be taken for granted that because saltpetre and the salts of lime produced such good results on our soils they will necessarily produce as good results on other soils; for if a soil is rich in lime or potash, it will not benefit it greatly to apply either; though there are few soils under cultivation that will not repay the cost of either, still those results indicate the kind of food most acceptable to the cholum tribe. Each farmer should experiment, and thus ascertain for himself the wants of his soil.

"The fodder is very valuable; all kinds of stock are extremely fond of it; it is quite unnecessary to chaff the straw; both the cattle and sheep eat every particle placed before them. It is rather difficult to keep it from the attacks of ants, its extreme sweetness rendering it very attractive to them.

"After removing the crop I had the stubble watered and manured, and there is now a fair second crop. But to secure the largest quantity of fodder the crop should be cut at an earlier stage than in the instances under review. We cannot hope to obtain both the maximum quantity of fodder and the maximum quantity of grain. If we obtain a large yield of the one, we must be content with a lesser yield of the other."

Comparison of sorgho with other forage crops.

40. Mr. Robertson gave the following as the average outturn from the different fodder crops with which he had experimented on the farm:—

Crops.	Weight per acre of green fodder.	Average number of days required to produce a crop.
	lbs.	Days.
Yellow cholum (*sorghum vulgare*)	10,000	90
Yellow cholum (*sorghum vulgare*), specially irrigated	12,000	60
Chinese sugarcane (*sorghum saccharatum*)	20,000	80
Cumboo (*penicillaria spicata*)	15,000	75
Horse gram (*dolichos uniflorus*)	7,000	70
Common paddy, specially irrigated	8,000	65

From this table it would appear that of all the crops usually cultivated for forage in the Madras Presidency, sorgho yields the greatest amount of fodder to the acre. These figures, too, shew the results of one cutting only; but sorgho is also superior to cholum, the next crop in the list, when both crops are allowed to rattoon.

In an experiment made on the farm with yellow cholum (seed sown in December and the land irrigated) five cuttings were obtained, yielding 50,000 lbs. of green fodder, these cuttings extending over a period of eleven months. Sorgho, on the other hand, will give as large a yield of fodder, and from three cuttings, and the crop will not occupy the ground so long; indeed, under high cultivation on the Government farm at Allahabad, a yield of 50,000 lbs.

has been obtained from one cutting, the crop remaining on the ground from three to four months only. Further, a sowing of cholum, in the month of June, gave on the farm three cuttings in eight months, yielding only 17,000 lbs. of green fodder; while sorgho, cultivated under the same circumstances as the cholum, gave 20,000 lbs. of forage from one cutting.

Sorgho as a grain crop.

41. In some experiments made in 1871 to test the value of sorgho as a grain-crop, the average yield per acre obtained was 1,090 lbs. of grain, with 17,000 lbs. of straw. The grain was valued at 25 lbs. to the rupee. The average yield of yellow cholum, cultivated at the same time and under the same circumstances, was 800 lbs. of grain, valued at 45 lbs. to the rupee, and 5,000 lbs. of straw. Red cholum yielded 500 lbs. of grain and 4,000 lbs. of straw to the acre. Sorgho, then, cultivated as a grain-crop, is superior to cholum, the yield both of grain and straw being much heavier, while each product has a higher value than that of the cholum. All three crops,—sorgho, red cholum, and white cholum,—were sown in October, the sorgho being reaped in January and the cholums in February. For the sorgho 15 lbs. of seed were sown to the acre, and for each of the cholums 24 lbs.

Establishment of sorgho on the Sydapet farm as a cold-weather crop.

42. In all the experiments on the Sydapet farms the sorgho was sown at the same time as the cholum, *viz.*, in the month of October, and reaped in December or January. The soils on the farm, Mr. Robertson remarked, are of a light, sandy, inferior description, and both the sorgho and the cholum, he said, do best on loamy soils. In his Annual Report for the year ending 31st March 1872, Mr. Robertson said that there had been a considerable area of land under sorgho during the season of 1871-72, the crop having established itself at Sydapet as one of the regular cold-weather crops. A large quantity of seed had been distributed over the country from the farm, and in most instances satisfactory results had been obtained.. The reports of experiments in Bangalore, Mr. Robertson said, were *very* encouraging, the crop seeming especially suited to the more temperate climate of Mysore. Mr. Robertson made several attempts to grow sorgho in the hot weather, but without success. The seeds would germinate well, and there would be a good quantity of plants, which, however, were invariably sickly and stunted; and the hot-weather crop never, under the most favourable circumstances, produced more than one-fourth of the cold-weather crop. He had, however, some hopes of establishing sorgho as a hot-weather crop, as some sorgho seed which had come into a field of cumboo as manure, from stalls in which the cattle had been fed on sorgho fodder, had sprung up and grown well with the cumboo in the hot weather. Mr. Robertson said that the Sorgho could be grown as readily and with as little skill as the ordinary cholums cultivated by the ryots; and he described the method of culture adopted on the farm as follows:—

Failure as a hot-weather crop.

Easiness of sorgho cultivation. Method adopted on the farm.

"We usually put in our sorghum crop in a very simple way. The land is first ploughed, scarified, and weeded, and then the manure is broadcasted over its surface. This is then ploughed in, and the land is harrowed along the lines, the plough travelled (not across, as the harrow would pull up the manure). It is then rolled, and the seed is sown with the seed drill (the country bamboo drill answers admirably), at distances varying from 12 inches to 18 inches according to the richness of the soil, at the rate of from 12 to 15 lbs. per acre.

"We have occasionally steeped the seed before sowing it, but I find that in dry weather the seed is more liable to suffer injury by being steeped and softened before being sown, while in damp weather there is *no necessity* for steeping it. We have also sown sorghum on ridges, and this is the best way to get a *large* crop: but it is rather a tedious process in a *hasty* season, and cannot always be adopted. The land is prepared, as for sowing, on the flat up to the time it is pulverized and cleaned; it is then ridged up by means of a plough in ridges about two feet apart. Manure is spread in the furrow between the ridges, and is covered by passing the plough along through the drills. The ridges raised over the manure are either rolled or harrowed, and the seed is sown along their tops. When the plant is grown under irrigation the practice just detailed is followed, and the water is allowed to flow between the ridges on which the crop is growing. It has been suggested that transplanting might suit the habits of the sorghum plant, but it is seldom in this country that this can be done without *great* expense and seriously delaying farm-work. Transplanting may answer well enough for planting a few square yards with sorghum in a kitchen

garden, but is altogether unsuited for operations in the field, excepting perhaps under irrigation."

Sorgho in other parts of India.

43. In other parts of India experiments seem to have been given up altogether, and sorgho was allowed to fall into neglect.

The experiments that had been made, however, proved the crop to be a profitable one, and although sorgho was very generally neglected, its valuable properties recommended it to some, chiefly European planters in Upper India, who cultivated it as forage for their cattle; it appears, too, to have been under cultivation to a small extent by the natives in certain localities for the sake of its grain. It has established itself on the stud farms in the Bengal Presidency. Seed of the imphee was received at the Ghazipur Farm in 1861, and the imphee has ever since that time been largely cultivated on all the stud farms, the Superintendent of Studs reporting in 1871, that it had been found to be a most valuable forage plant. The imphee has also established itself in the Kangra District of the Punjab, where, Mr. Baden-Powell in his *Punjab Products* says, it is used "as a valuable fodder for cattle." In the Punjab the imphee is called *Jowar Wilayiti*. Sorgho is also grown to a small extent in Burma, and its value for providing a nutritious fodder for cattle is there fully recognised; but as fodder is plentiful, the crop is not in extensive cultivation, except in parts of Upper Burma, where fodder is more scarce. The stalks of the sorgho are there used as forage for cattle and ponies, and the seed as a substitute for rice. The small quantity grown in British Burma, which is chiefly in the Pegu Division, is put to the same use that the Chinese and the Kaffirs make of the sorgho, *viz.*, the stalks are chewed for the sake of their juice. It is used thus as a cheap substitute for sugarcane, and here the advantage that it has over the ordinary sugarcane, in being more easy of cultivation and in coming to maturity much earlier, is brought into practical use in the same way as in China and Africa. The grain is used, too, as in Upper Burma, *viz.*, parched, or in curries, as a variation from the ordinary rice diet, and the stalks and leaves are given to cattle. The plant cultivated by the Burmese, which is said to be the *Sorghum saccharatum*, is called by them "Pyoung-lai-gouk," and grows to the height of eight or nine feet only.

The Secretary to the Agri-Horticultural Society at Rangoon, who had imported seed of the Chinese variety from Australia for experiment, reported in July 1871 as follows:—

"*Sorghum saccharatum* has been grown in the Agri-Horticultural Garden here from a packet of seed received from Melbourne, Australia, where it is largely grown for the forage of cattle and horses. The experiment last year was very successful; the cattle to which the leaves and stalks were given ate it with avidity: a quantity of seed was saved, some of which was given to a gentleman in the Rangoon district for trial, and some to native (Madras) cultivators about the suburbs, where *sorghum* may be seen growing in small patches in their small holdings, grown, I believe, more for the sake of the grain than as forage. That it can be easily naturalized here, I gather from the fact that in the beds where it was grown last year, self-sown plants have come up this season from the droppings of the seed when the heads were cut.

"There is a difference in the colour of the seed received from Australia, the Indian varieties being either of a brownish or greenish yellow*: the former† are of a deep shining brownish black. The seed was sown thickly in a box in August last year, and when the seedlings were about three inches high they were pricked out and sown in beds which had been weeded and turned over once or twice (without manure) with mamooties. The plants grew vigorously, and when the heads began to form, in October, the stalks being between one inch and an inch and a quarter in diameter, they had attained the uniform height of ten feet, although one or two that I measured were over twelve feet in height. There is no doubt that it can be converted into valuable food for cattle. Cows fed on this forage are said to yield abundance of milk."

It was not thought that the Burmese agriculturists would take to the cultivation of sorgho as they are well supplied with fodder, and as the Guinea grass, which has been lately introduced, is said to be best adapted to the country; but the fact that sorgho forage can be stacked and kept dry for use in the rainy season is one which may eventually recommend the plant to the Burmese.

* It is the *imphee*, evidently, that is referred to here.

† The Chinese Sorgho.

44. Sorgho, after having been neglected and uncared for for some years, was again brought prominently to notice in the year 1871. Colonel Boddam, who was specially deputed to initiate measures for the improvement of the condition of cattle in the province of Mysore, drew the attention of the Government to sorgho, which, from the accounts of its cultivation in America, and on the results of some experiments of his own, he strongly recommended as an important addition to the forage crops of that province. Colonel Boddam described sorgho as a very luxuriant kind of cholum, and he said, as an instance of its hardiness, that it had come up self-sown in the hot weather on fallow land where he had previously grown it, some of these seedlings, after the main stalk had grown up five feet and was cut down, having again thrown out six and seven large canes six feet high in full leaf, besides three or four small ones, giving, as he said, "an immense amount of fodder from a single plant."

Sorgho again brought prominently into notice in 1871.

Colonel Boddam's description of sorgho.

45. The following is a copy of Colonel Boddam's memorandum, dated May 1871, and revised in July 1872, on the subject. This memorandum was published in the *Mysore Gazette* of the 20th July 1872:—

His Memorandum.

SORGHO (SORGHUM SACCHARATUM).

Northern Chinese Sugarcane.

A new forage plant for dry and wet cultivation.

"This remarkable plant is a native of the north of China. Its giant growth and its beautiful and graceful appearance and refreshing greenness in the driest season, and the expectation of finding in it a rival to sugar-beet, induced the French Consul at Shanghai to send some sorgho seed to his Government. In 1854, Mr. Browne, Agent of the United States Patent Office, took to America some French seed, which was distributed by the Government. The plant was cultivated by a few farmers, but it received little attention until an ex-Governor of South Carolina reported the results of his trials to a farmers' club, which brought sorgho into notice. Since 1855 its cultivation has steadily increased, and it is now one of the great crops of the country. It is grown in France and Algeria for alcohol chiefly, and in America for seed, forage, sugar, syrup, alcohol, vinegar, and beer. In the ten North-Western States where it flourishes, there were, in 1864, 366,670 acres of sorgho, and sorgho sugar was selling at Chicago at 4½*d.* per lb. But for sugar, sorgho has turned out a failure. Its great merit as a forage plant is its principal recommendation, and on this point an official report of the United States Agricultural Department has declared that *the value of sorgho for feeding stock cannot be surpassed by any other crop, as a greater amount of nutritious fodder can be obtained by it in a shorter time, within a given space, and more cheaply.* While grass yields a ton or a ton and-a-half of hay, sorgho will yield from two tons to nine tons of dry fodder. Sorgho (*Lootsoh*) flourishes wherever Indian-corn flourishes.

"The seed is sown for transplanting on warm ground, finely broken, in the middle of April. The young plants are watered with liquid manure as soon as they appear, and for three or four days watering is repeated night and morning, if the weather is dry. They are pricked out, when six inches high, in rows three feet wide and six inches from plant to plant, and are again watered with liquid manure when a foot high. Weeds are kept down by hoeing until the cane matures, about November. The crop begins to come to market, however, early in September, or as soon as the stalks are sufficiently sweet for chewing. A Chinese labourer earning 10*d.* a day can cultivate about two acres during the six months that the crop needs his labour.

Chinese method of growing sorgho.

"In America it is found that sorgho can be successfully grown on all lands where a fair crop of Indian corn can be grown. Deep, loose, warm soil, even of poor quality, produces the sweetest and most juicy stalks. Irrigation is recommended, but can seldom be attained in the United States. In deep black loam sorgho reaches a height of 16 feet or 18 feet;—what will it not do on our future sewage farms? The juice of the giant growth is not so sweet, nor is it easily crystallised. The seed should be soaked twenty-four hours in tepid water, in which one ounce of saltpetre is dissolved to every six gallons. It is then dusted with gypsum, and drilled two feet apart and twenty seeds per foot (for forage). In seven or eight days a horse sub-soil plough is put between the rows, up one side, down the other. This cultivation is repeated as the crop advances, but the plants must not be earthed up. The upper roots spring from the stalk above the ground, and they must be left exposed. The first cutting may be made as soon as the crop is large enough for stock, and in ordinary seasons two others will follow. To dry the crop it should be set up in shocks, and the shock built with precautions for ventilation. One man with a sub-soil plough can cultivate ten acres."

American culture.

Directions for growing Sorgho in the Mysore Province.

"The Chinese and American methods of cultivating sorgho will answer in Mysore, each at its proper season. If the crop is to be sown in the early rains of April and May the Chinese system is recommended, as there is less risk of failure from drought by sowing in a nursery bed and subsequently planting out in rows. Failure must sometimes occur when the seed is sown in drills at this season, as the rain often holds off for a fortnight or three weeks and the sprouting seeds or seedlings perish from want of moisture. Later, when the rains are regular and copious, the American system will be more suitable, with the following modifications:—

"Plough the land well and deeply, apply manure liberally, say from six to seven tons of farm-yard manure per acre, and if saltpetre is procurable and cheap add it at the rate of 100 lbs. per acre. Plough this manure crosswise to the first ploughing, harrow and level, then sow the seed in drills twenty-six inches apart, and twenty seeds per foot. In seven or eight days put a bullock hoe or cultivator between the rows, up one side, down the other, or hoe the rows by hand. Continue the cultivation as the crop advances, but in no case earth up the plant stems, as they send out roots above ground which must be left exposed. The first cutting should be made just before the canes show signs of flowering; the plants will send out side shoots two or three at a time for successive cuttings, affording a supply of excellent green fodder extending over a period of six or eight weeks. If the crop is to be used for dry fodder, the canes, when cut, should be set in shocks, and the shocks built with precautions for ventilation. If the crop is required for seed only, the leader of the canes should be left to flower and mature its seed, while all the side shoots may be cut for fodder.

"Under this system of dry cultivation and high farming at Húnsúr near Mysore, a plot of 1,296 square yards of very rich land, which had long been under cultivation, and was heavily manured beforehand, produced 12,657½ lbs. of fodder and 1,498½ lbs. of seed, equivalent to 21 tons, 1 cwt., 1 quarter, and 10 lbs. of fodder per acre, and 2 tons, 9 cwts., 3 quarters, and 5 lbs. of seed: this very large outturn is attributed to the extreme richness of the land, a favourable season, and high farming. Again, in the Túmkúr District, in the rich black soil of Gubbi, where sorgho was tried, the canes attained the height of 18 feet, and a very heavy crop of fodder was cut. Unfortunately the weight per acre was not recorded. On the average light soil of Bangalore, with a moderate supply of manure, upwards of 10 tons of fodder were cut per acre. Even this last-mentioned crop far surpasses the outturn of any grass grown in the province, and is superior to the average outturn of an acre of the country jowar or cholum.

"So much for the results of high farming; no doubt in favourable seasons a fairly remunerative crop might be raised even under the native system of light ploughing, scanty manuring, and careless weeding.

"The seed could be sown with the Súdiki*— (see Buchanan's Mysore, page 261, plate XI) —or country pulse drill; three of these pulse drills tied to the native harrow and served by three men would do for the sowing process, followed in due course after a fortnight by the country bullock hoe.

"There are a great many kinds of so-called sorgho (the two real sorts are the imphee, or red seed† already known in parts of India, and the black seed of North China), the last-mentioned containing most saccharine matter. As the several kinds hybridize freely they should be grown separately, never near each other: when the seed is formed the crop must be watched and birds scared; parrots are particularly fond of the seed and destroy immense quantities if left undisturbed.

"To sum up; the superior merits of the *sorghum saccharatum* over grasses consist in (1) its heavy crop; (2) the rapidity of its growth; (3) its abounding in saccharine matter; (4) its power of standing heat and drought, and of being grown nearly all the year round, especially in the dry and hot months, when every kind of grass is burnt up; and lastly, that with high farming it is a most remunerative crop."

46. Colonel Boddam obtained the seed with which he experimented from England. His attention was first drawn to sorgho by seeing extracts from papers which had been read to the Asiatic Society in 1870, stating that sorgho was extensively cultivated for forage in America. Writing of sorgho in April 1872 from Bangalore, Colonel Boddam said:—

"In my paper on its cultivation I pointed out that sorgho is grown in North China in the summer, which is there exceedingly hot, and here I find it does best as a dry crop, when sown in the earliest rains that precede the monsoon. Here we get showers in May, and I found the sorgho came up then self-sown on the plot I had cultivated the previous cold season, and that the self-sown plants did well without any care whatever; they were in fact superior to the crop sown and carefully cultivated at the end of June. This year again I grew some sorgho at the beginning of the year, and am cutting it daily now for my cattle, the crop standing the heat and drought of our Bangalore summer very well, and being most acceptable to the cows and calves when it is impossible to get any other green food.

---

* Also styled Sadde or Kal Kurige.

The *Otaheitan* variety of the imphee is red seeded. This is the variety most generally cultivated of all the imphees in the United States of America, and probably, too, in India.— F. G. W.

54892

"The sorgho sown in the beginning of the year has only been occasionally watered, say once a week or once in eight days, and this has been a most unusually dry and hot season. Another point worthy of notice is that the crop is not cut all at once, but as the plant sends out successively a series of six to eight canes these should be cut successively when the flower expands, so that you can obtain a quantity of green food spread over several weeks; and it is when cut in this manner that the enormous weight of fodder is realised; whereas with jowaree, the stalk is cut down once and there is an end of it. * * * *

"The seed, besides being utilised as seed-corn at the rate of 1½lbs. for an acre, can be made very useful for feeding poultry; they are very fond of it when once accustomed to it. Pigeons and parrots I had to scare away from the field."

47. Colonel Boddam thought that there was no doubt as to the success of sorgho as a first-rate forage crop for Mysore, and he remarked that the cows at Bangalore which had been fed on sorgho immediately improved in condition, and that the butter made from their milk greatly increased in quantity. This was certified in the local newspaper, and without reference to Colonel Boddam in any way; indeed, it is well known that the saccharine richness of the sorgho makes it especially valuable as fodder for milch cows.

Further experiments undertaken in the several provinces.

48. Colonel Boddam's memorandum was forwarded to the several local Governments and Administrations under the Government of India, with instructions for extensive circulation to all who would be likely to take an interest in sorgho. Experiments with sorgho as a forage crop were then systematically undertaken, and with the following results:

Mysore.—The earlier experiments.

49. The Chief Commissioner of Mysore, reporting on sorgho in July 1871, said that in 1859 seed of the Chinese sorgho, which had been obtained from America, was, at the request of the Madras Board of Revenue, distributed throughout the province for trial. The results of these experiments were not on record, but the Chief Commissioner had been informed "that although the soil and climate were not found to be at all inimical to the plant, no desire was evinced by the people to extend its cultivation; and, as in other cases, the prejudices of the people, whether well founded or otherwise, proved fatal to any expectation of the plant being introduced generally for cattle forage, in which its chief utility consists."

Experiments in 1870-71.

50. In 1870 sorgho was tried again, at the instigation of Colonel Boddam, but only on a very limited scale. In 1871 all the experiments carried out in various parts of Mysore (seed having been sown in June) turned out badly owing to the continued want of rain. Colonel Boddam, however, managed to raise a crop in the same season, and the Superintendent of the Cattle Farm at Húnsúr, who planted as a cold-weather crop, obtained very satisfactory results.

By Colonel Boddam.

On the 24th June, Colonel Boddam sowed 2,364 square yards of land with seed, according to his own method, *viz.*, at the rate of 20 seeds per foot in drills 26 inches apart. The land was deep-ploughed with English ploughs, and the subsequent cultivation was with bullock hoes of improved English pattern. The crop, being grown for seed, was not cut till the 3rd November, when the yield per acre was at the rate of 470 lbs. of seed and 13,144 lbs. of green fodder.

At Húnsúr.

The Superintendent of the Cattle Farm at Húnsúr sowed 1,296 square yards with sorgho seed in October. The land was dressed with line manure, and the experiment was carried out on the dry cultivation system. The yield of green forage, cut in January, was at the rate of 47,190 lbs. or over 21 tons, and of seed at the rate of 1,498 lbs. per acre. This large yield is one of those referred to by Colonel Boddam in his memorandum.

The Chief Commissioner's opinion of sorgho.

51. In forwarding the reports on the above experiments the Chief Commissioner observed as follows:—

"With respect to the value of sorgho as an article of fodder, there appears to be no doubt that it will grow fairly in this province as a dry crop, *i. e.*, or on land not irrigated during the rainy season, and that if cut for fodder before seeding, it is well suited for cattle, especially milch cows, their milk being enriched to an extraordinary degree by its use in small quantities. The natives, however, do not appear to care for or value it, and probably think more of the ordinary *cholum charra* (or jowar fodder stalk), which grows to a height of 10 or 12 feet in many fields near Bangalore."

The Chief Commissioner was anxious to have induced some of the large cattle-owners of Bangalore to arrange for the cultivation of sorgho for the use of their cattle, in sufficient quantities to give the value of the plant as fodder a fair trial; but he was not able to succeed in interesting them in the plant.

Colonel Boddam's further experiments: 1872.

52. Colonel Boddam continued his experiments with sorgho in the years 1872 and 1873. In 1872 he grew the crop again for seed. Eighteen pounds of seed were sown on the 1st July on an area of 1 acre and 2,087 square yards. The only manure used was indifferent farm-yard manure, and the crop was cultivated in the ordinary native way. The total outlay incurred, including Rs. 6 for threshing and cleaning the seed, Rs. 8 for watching the crop as a protection against birds, and Rs. 4-6 land assessment, was Rs. 38-14, the produce being 17 tons of green fodder valued at Rs. 19, and 860 lbs. of seed valued at Rs. 43,* or a total value of Rs. 62, giving a profit on the crop of Rs. 23-2. The results per acre would have been, approximately—

Cost of cultivation							Rs.	27	2 0
Yield of green forage,	12 tons, valued at ...				Rs.	13	0	0	
„ seed,	601 lbs., „ ...				„	30	0	0	
Value of yield							„	43	0 0
Profit							„	15	14 0

Colonel Boddam compared this result with raggy and jowar, which are largely cultivated as dry crops for fodder in Mysore. The cost of culture of the same area, *viz.*, 1 acre and 2,087 square yards, of either of these crops would have been Rs. 10-7-9; the value of the produce Rs. 16-4-2 (seed and fodder); and the profit on either crop Rs. 5-12-5, which is much less than the profit yielded by the cultivation of sorgho, which was Rs. 23-2. The greater value of the seed of the sorgho, in comparison with that of the raggy and jowar, is the chief cause of this result.

1873.

53. In his next experiment, in 1873, Colonel Boddam sowed in May. He sowed an acre of what he termed "average land" with 20 lbs. of seed on the 25th of the month, and thus described the culture, —

"The land having been heavily manured, one simple ploughing with the native plough was followed by the country harrow. The seed was then sown broadcast and the harrowing continued till the seed was covered. When the crop was about six inches high it was thinned by a harrow being drawn over it, as is done in raggy culture at the same stage of growth. No further culture was needed, the sorgho growing so rapidly as to smother all weeds and grass. As the canes began to show flower they were cut in succession, affording two cuttings from each plant, spread over a period of about three weeks. By the end of 2½ months the crop was cleared off the land, which was then broken up for another rotation crop."

Comparison with white cholum.

An acre of land was at the same time sown with *kaka cholum* (white cholum, a variety of the *Sorghum vulgare*, which the ryots at Bangalore grow in the rainy season as a green forage crop) in order to compare the outturn with that of the sorgho; and the sorgho turned out the best, the yield having been 9 tons or 20,160 lbs. of green fodder, which was cut between the 25th July and the 10th August, valued at Rs. 54-12-9, while the yield of fodder from the cholum, which was not ready for cutting till the end of September, was 7 tons or 16,560 lbs. only, the value being Rs. 45. The total cost of cultivating the sorgho was Rs. 21-12, leaving a profit on the crop of Rs. 33-0-9; and of the cholum Rs. 21-6, leaving a profit of Rs. 23-10.

In the above experiment one-third more manure was spread on the land for the sorgho than for the cholum, as the land under the latter crop was superior to that under the sorgho; and the crop yielded about one-fourth more in fodder, besides being cut in 2½ months instead of 4 months as with the cholum. After the sorgho was cut the land was broken up and another crop grown on the same plot during the same season.

The above, Colonel Boddam explained, does not shew the *largest* outturn either crop would under ordinary conditions be capable of giving, as the season was an unfavourable one, a long drought having ensued after the first rains, which was followed by very heavy continuous rain towards the end of the experiment.

* The seed is here valued at 20 lbs. per rupee, which is the price at which it was selling at Bangalore.

In recording this experiment Colonel Boddam thought that, though, as dry fodder, raggy and paddy-straw were preferable, as a green fodder plant sorgho was most valuable—growing at the time that dry fodder is very scarce and very expensive, being relished by cattle, and being of very rapid growth, more so than the ordinary cholum; besides that it could be grown almost all the year round.

Value of sorgho as a green forage crop.

54. An experiment with sorgho was made at the Lal Bagh, in Bangalore, in the same year, 1873. Mr. Cameron, the Superintendent, sowed the seed, from 15 to 20 lbs., on an acre of land in the month of November; but he thought there was no reason why the date of sowing should be limited to any particular month, as the quality of the ground and peculiarities of climate throughout the different parts of India would suggest their own seasons. The soil was slightly manured and the crop came up very thickly, so much so that Mr. Cameron thought that from 12 to 15 lbs. of seed would be sufficient to sow an acre. Mr. Cameron said that the plants decidedly object to much moisture, either at their roots or on the foliage, and he thought that they should be exposed to a warm sun during the ripening period, as when this is the case the grain swells out considerably, thereby adding to its weight and value. The crop was reaped in the beginning of February, and yielded 825 lbs. of seed and 5 tons of fodder (not stated as green or dry). The expense of labour, Mr. Cameron observed, does not exceed that of putting down any ordinary crop, provided the ground is in a cultivated state.

Experiment at the Lál Bagh.

The above were the only experiments of any value in Mysore. The experiments made by the natives who were supplied with seed came to nothing, and were not reported.

55. The imphee was very favourably reported upon as a forage plant after the experiments made with it in the Bombay Presidency in 1860. Although pronounced unable to compete with the ordinary sugarcane as a sugar-producer, the imphee was admitted to be of great value as a forage plant. Mr. N. A. Dalzell, the Superintendent of the Dapoorie Botanical Gardens in Bombay, who reported on these first experiments in the Presidency, while having a high opinion of the imphee as a sugar-producer, thought "that if it was regarded simply as a forage for cattle of the most superior description, it would be desirable to persevere in its cultivation." The imphee karbi realised in the Poona experiments, he said, went five times as far as the ordinary karbi.

Bombay.—The earlier experiments.

56. On the revival of experiments with the Chinese sorgho in 1872, the most sanguine expectations were formed of the plant proving a valuable addition to the fodder crops of the presidency. Some experiments made at the Botanical Gardens at Gunesh Khind in 1874 were very successful. Mr. Woodrow, the Superintendent of the Gardens, described sorgho as a kind of millet, distinguished from the varieties of jowar that are cultivated in the Deccan by the flower panicle being open and loose and the testa of the seed dark brown or black and shining. Mr. Woodrow sowed seed of the sorgho on the 25th March, at the rate of 30 lbs. to an acre. On four plots, out of seven sown, the yield of green forage was per acre 10, 11, 11½, and 14 tons; equivalent when dried to 4, 4⅘ths, 4⅗ths, and 5⅕ths tons, respectively. The plants on the other three plots did not turn out well. The soil used was a very poor exhausted black soil, but it was very heavily manured for the sorgho; and the crop was grown as an irrigated green forage crop.

Experiments at Gunesh Khind.

In a further experiment, in which the seed was sown later in the year, *viz.*, on the 10th June, and on unmanured land which had lain fallow for a number of years, the crop being treated in the same way as jowaree, the yield was at the low rate of 12 cwts. of dry fodder per acre, the yield of seed, which was not allowed to ripen, being estimated at 2½ cwts. The value of the fodder and seed was estimated at Rs. 10 and Rs. 26 respectively per ton, and the

following comparison with the average yield in the district and profit per acre of bajra and jowar was made :—

Sorgho.

	Rs.	A.	P.
12 cwts. fodder, at Rs. 10* per ton	6	0	0
2½ cwts. seed, at Rs. 26* „	3	4	0
	9	4	0
Cost of cultivation and rent per acre	6	0	0
Profit per acre	3	4	0

Bajra.

	Rs.	A.	P.
8 cwts. fodder, at Rs. 6 per ton	2	6	0
3½ cwts. seed, at Rs. 30† „	5	4	0
	7	10	0
Cost of cultivation and rent per acre	6	0	0
Profit per acre	1	10	0

Jowar.

	Rs.	A.	P.
10 cwts. fodder, at Rs. 9 per ton	4	8	0
2½ cwts. seed, at Rs. 28† „	3	8	0
	8	0	0
Cost of cultivation and rent per acre	6	0	0
Profit per acre	2	0	0

In his report on the above experiments Mr. Woodrow wrote as follows: — "Sorgho has been introduced into this district several times during the last 30 years,‡ and recommended as a sugar-yielding crop, a character which, although deserved, is of little value where sugarcane flourishes. The seed having a hard black testa, and yielding a bread which does not please the eye, has prevented its being taken up by the natives as a regular crop; and the high value of the forage is a matter which does not command immediate attention. Persistent cultivation on Government farms will certainly bring it into use, and the advantage for fattening cattle can scarcely be estimated."

Experiments in Dharwar and Khandesh.

57. In the District of Dharwar the experiments were a failure, and sorgho was called "a poor imitation of shaloo, or white jowar." In Khandesh it was not thought worth while to cultivate sorgho, as grass there is plentiful and cheap. Sorgho was in Khandesh compared unfavourably with jowar, "of which, indeed," it was said, "it is merely a black variety."

Sind.

58. The climate of Sind appears to be particularly suited to the cultivation of sorgho. There were excellent results to the first experiments made with the imphee in Sind in 1860; and the later experiments in 1872-74, with the Chinese sorgho, were also very satisfactory.

Experiments on the Model Farm at Salaru.

The Superintendent of the Model Farm at Salaru, in the Hyderabad Collectorate, made experiments in 1872, 1873, and 1874. In 1872 he sowed only 10 guntas of land, and obtained a yield at the rate of 32 lbs. of seed and 13,033 lbs. of green fodder to the acre. In 1873, sowing on the 24th June, he obtained 935¾ lbs. of seed and 9,774 lbs. of green fodder, reaped on the 6th October, to the acre. Two sowings were made in 1874. From the first sowing, of 2 acres, in the beginning of June 1874, the yield was 75,432 lbs. of fodder, with a second cutting from one acre of 1,409 lbs., being at an average per acre on the sowing of 38,420 lbs. of green forage.

From the second sowing in 1874, of 2⅛ acres, between the 17th and 28th July, the yield obtained was 8,198 lbs. of green fodder, or at the rate of only

---

* Estimate of value.

† Poona prices in November 1874.

‡ This is evidently a mistake. Sorgho was not introduced into India until the year 1858.

F. G. W.

3,279 lbs. to the acre. Compared with bajra cultivated at the farm, the following are the results of the cultivation of sorgho :—

	Bajra.	Yield per acre.	Value at bazar rate.	Sorgho.	Yield per acre.	Value at bazar rate.	Remarks.
		lbs.	Rs. A. P.		lbs.	Rs. A. P.	
1872.	Seed ...	1,066	28 8 10	Seed ...	32	0 13 8	
"	Fodder ...	1,886	3 1 9	Fodder ...	13,032	21 7 11	
1873.	Seed ...	790	21 2 7	Seed ...	936	25 1 2	
"	Fodder ...	5,678	9 5 10	Fodder ...	9,774	16 1 4	
1874.	Seed* ...	418	11 3 0	Seed ...	...	...	* The yield of bajra in 1874, it was explained, was very low, the sowing having been made too late in the season.
"	Fodder ...	3,293	5 0 11	Fodder ...	38,420	63 6 0	
				2nd sowing Seed ...	...	...	
				Fodder ...	3,279	5 6 6	

The seed of the sorgho and bajra is here valued at the same rate, *viz.*, about 9 annas for 21 lbs. The sorgho fodder is valued at Rs. 100 per bundle of about 4,050 lbs.,—a higher rate than the bajra fodder.

Luxuriance of the sorgho crop.

59. The first sowing of sorgho in 1874, the Superintendent of the Farm remarked, was the most luxuriant of any cereal crop ever raised on the farm. The crop was cut in a partially green state daily as required for the cattle. The average height of the crop was 11 feet, and some of the stems measured over 14 feet. After September the crop was much damaged by insects, and the forage lost some of its richness in consequence. The land had been well manured and ploughed with the English plough during the cold weather, and the sowing and after-culture adopted was the same as for bajra or jowar. The cost of raising a crop of either sorgho, bajra, or jowar, the Superintendent remarked, would be almost the same; and "all of them like rich ground and there is no difference in the culture." The opinion of the Superintendent of the Farm regarding sorgho was as follows :—

"The grain is unsaleable here. The Karbi would, during the early part of the season, bring about the same money per 100 bundles as would jowar grass. It is best suited for an early fodder crop; after the culms become mature insects destroy it on account of the sweetness of the juice. For a general crop it is inferior to either bajra or jowar, but superior as an early fodder crop for use during the hot-weather cultivating season. An early sowing on well-manured land will give a cutting every third month, that is, two cuttings during the season. Working cattle require less oil-cake and cotton-seed to keep up their working powers when fed on sorgho than they do when fed with bajra karbi."

Verdict of the native cultivators.

The native cultivators in Sind, who received seed for experimenting for the first time in 1874, all agreed that sorgho was a good fodder crop for the early part of the season, and the Superintendent remarked that they seldom give so favourable an opinion of any new crop as they had done of the sorgho.

Sorgho, however, may not come into extensive cultivation in Sind, as its grain is not valued; and, as the Collector of Hyderabad observed, the Sindhis do not cultivate any crop merely for forage, the staple food for cattle—the stalks of the jowar—being, in their opinion, preferable to anything else which would not produce grain as well as grass. It might, however, it was thought, be more appreciated in the neighbourhood of populous towns and villages, where there would be a market for its grain; and it was proposed to distribute seed among the cultivators in such localities with a view to ascertain whether sorgho would find favour as an addition to the few varieties of fodder which Sind possesses.

Experiments at Deesa.

60. Some experiments were made by the Commissariat Officer at Deesa in the Bombay Presidency. That officer, attracted by a notice in the *Times of India* regarding the value of sorgho as a forage plant, obtained seed from Colonel Boddam at Bangalore with a view to making experiments. On the 1st April 1872 he sowed $3\frac{3}{4}$ lbs.

of the seed with which Colonel Boddam supplied him, on a piece of land measuring 682 square yards. The soil being of a light sandy description, it was ploughed to a depth of 2 feet and well manured with sheep dung; grain had never been grown on it before. The quantity of seed realised from the crop was small—31 lbs. only; but the green Karbi produced, which was cut between the 23rd and 28th July, weighed 4,605 lbs., being at the rate of 32,680 lbs. per acre. The probable value of the Karbi, the Commissariat Officer thought, was Rs. 23, reckoning it at Rs. 5 per thousand pounds; and he said that "the Karbi grown seemed first rate, and is a very sweet and nourishing fodder for the slaughter cattle, which relished it much."

Bengal.—Experiments by Dr. Henderson.

61. Experiments have not been made to any large extent in the Bengal Presidency. In 1872, Dr. Henderson, who was then officiating as Superintendent of the Botanical Gardens at Calcutta, made an experiment with two pounds of seed, which he sowed on the 17th July on a piece of ground measuring 1,680 square yards. The yield was 5,800 lbs. of green fodder, cut between the 13th August and the 30th September, and 3,680 lbs. as a second crop, cut in October; or a total yield of 9,480 lbs., being at the rate of 27,311 lbs., or rather more than 12 tons to the acre. Dr. Henderson gave the following information regarding the plant:—

"I believe it has been repeatedly tried for very many years in various parts of India, and the reason why it has not yet established itself is probably because it requires a very large quantity of manure, as well as plenty of water. Many years ago I made experiments with it in the Punjab in every variety of soil, and found that it could be successfully grown almost anywhere; and, if well manured and liberally watered, it yielded a very large quantity of excellent fodder—considerably more, I think, than any other fodder plant with which I am acquainted—and could be cut five or six times during the summer. I also tried to extract sugar from the juice, and made some fair samples, which, as far as I recollect, had this peculiarity, that neither flies nor ants would touch it.

"On questioning the native gardeners here as to the quality of the fodder, I was told that it is so injurious to cattle that no one would take it as a gift, and that cattle would hardly eat it. It appears that the crop grown here last summer was offered to the villagers about, but they, seeing such fine fodder offered gratis, were naturally suspicious of it, and would have nothing to do with it. So the next batch was sent to the Commissariat; but the Commissariat Sergeant, learning that the villagers refused it, declined to let any experiments be made on the Government cattle. I need not say that there is no foundation whatever for this idea that the plant is injurious to cattle. I know as a fact that cattle are fond of it and thrive on it, and the bullocks in this garden are now eating it without any bad effects. I saw fields of the *Sorghum saccharatum* in Eastern Turkistan, near the city of Yarkand, where it was growing ten feet in height.

"My opinion of the plant is that it is one of the very best that can be grown for fodder, where plenty of manure and water can be given. The crop is no doubt rather an exhausting one, and it would just be the thing to grow where sewage irrigation can be obtained, and in saline, as reh soils. If it could once be got to germinate after flooding or draining the land sufficiently, I believe it would take up the excess of saline matter faster than almost any other crop."

Experiment at Monghyr.

62. In September 1873, the Collector of Monghyr reported that some plants that had been grown in the public garden at that place (seed sown in May) had attained the height of 17 feet, but that the natives, although admiring its gigantic growth, did not evince any interest in the plant as fodder for their cattle; and no applications were made for seed, which they all knew was to be had for the asking. The Collector thought that sorgho, if cut when about six feet high, had much to recommend it as a fodder plant, but he did not think that the cultivation of the plant would be taken up, remarking that "the fact is, that setting aside land merely to grow fodder for cattle is an arrangement which does not at all coincide with the views of native cow-keepers."

Other experiments in Bengal.

63. Some experiments made by the Executive Commissariat Officer at Hazáribágh did not turn out well. The other experiments carried out in the Bengal Presidency were all on a very small scale; but the reports tended to shew that sorgho could be successfully introduced into the presidency.

In the Purneah District, a few seeds were sown by Mr. McQueen, Sub-Manager of the Durbhunga estate, in October, and he had four cuttings of the plant in the months of March, June, September, and November following.

In the Chittagong Division sorgho seed sells at 7 pies per lb., and in the Lohardugga District of the Chota Nagpore Division, where about 125 acres of sorgho are under regular cultivation, the seed fetches from Re. 1 to Re. 1-4 per maund, the cost of culture being from 2 to 3 annas.

No experiments were made in Assam.

North-Western Provinces.

64. The most carefully conducted and most successful experiments with sorgho in the North-Western Provinces, and indeed in the whole of India, were those made on the Government Farm at Allahabad. Seed of the Chinese sorgho and the imphee was received on the farm in 1871, and in that and each succeeding year sorgho has been grown with great success and with profit.

In 1871, the sorgho was grown under the rough method of cultivation adopted by the natives, in order to test its value from that point of view as a forage plant, and in comparison with the jowar; and giving an outturn worth 1-3rd more than the jowar, it was grown again in the following year, on an increased area of land and under an improved system of cultivation. The yield in this year having been highly satisfactory, and the crop having been found a paying one, sorgho was grown again on a still larger scale in the years 1873 and 1874, and with increased profit to the farm in each year; and it has now established itself as one of the regular crops of the farm. The fact of the Superintendent's cultivating it, as he does, with a view to increase the profits of the farm, speaks very strongly in favour of sorgho cultivation.

Experiments on the Allahabad Farm: 1871.

65. In the first experiment, that of 1871, two plots of ground of one-and-a-half acres each were sown with sorgho and jowar. The soil was unmanured, ploughed, and prepared by the native ploughs, and both crops were treated in all respects in the same way as the native cultivators treat the common jowar. The seed, 10 lbs. of the sorgho and 15 lbs. of the jowar, was sown broadcast on the 27th June; the seeds were germinating freely by the 1st and 2nd of July, simultaneously with both crops; but during the next 14 days the sorgho took a decided lead, which it always maintained. Both crops suffered from a severe storm which took place on the 15th of the month, and this somewhat impeded their growth; but on the 4th September the sorgho was nine feet high, while the jowar was only 6½ feet. By the 1st October the sorgho had reached its full height of from 15 to 15½ feet, while the jowar on the same date was only 8½ feet high, and did not reach its full height of 12 feet until the end of the month. The two crops, however, were reaped at about the same time, *viz.*, the end of November, as the sorgho took much longer than the jowar to ripen its seed,—and the sorgho was grown specially for seed. After the sorgho was reaped, the plants started and grew away freely from the old stools, which is a great advantage, the Superintendent remarked, as affording a deal of green fodder late in the season when fodder is scarce. This point was greatly taken notice of, he said, by the native cultivators in the district. There was no second growth from the jowar.

The total yield from both crops in green fodder and seed was as follows :—

	Sorgho.		Jowar.	
	Yield.	Value.	Yield.	Value.
	lbs.	Rs. As. P.	lbs.	Rs. As. P.
Grain	400	6 10 8	640	10 10 8
Karbi, 1st cutting	10,400	16 4 0	8,800	13 12 0
„ 2nd „	6,480	11 9 1	...	.....
Total	...	34 7 9	...	24 6 8

The produce of the two crops is here valued at the same rate, *viz.*, a little over 3 pies per lb. for the seed, and Re. 1-9 per 1,000 lbs. for the fodder.

Failure of sorgho as a cold-weather crop.

66. An attempt was made in the same year to grow sorgho as a cold-weather crop. Seed was sown on the 1st November; it germinated well, and the young plants grew

to four or five inches high; but when the cold weather came on most of the plants dwindled and died out,—only a few which were protected by some plants of barley, the seed of which came in the manure, being left; and these, showing flower at 1½ foot high, the Superintendent thought, conclusively proved that the plant would not succeed in the winter. Sorgho is best cultivated in Upper India in the hot weather and rains. Several attempts to grow it in the North-Western Provinces as a cold weather crop have failed.

The imphee.

67. Mr. Phillips also made a trial with the African imphee. Seed was sown on the 3rd July, but the plants grew to the height of 3½ feet only, and the outturn was only about 1-8th that of the Chinese sorgho grown in the same year. Mr. Phillips thought that the imphee was not to be compared to the Chinese sorgho as a fodder plant. According to his experience, "the true sorgho (Chinese) grows from 17 to 20 feet high, while the imphee never attains half that height." Mr. Phillips said that he had seen a crop of imphee at Buxar in 1874, which was being grown for the Government Stud there, that had only attained five feet in height and was yielding only 150 maunds of karbi to the acre, while the Chinese sorgho on the Allahabad farm was at the same time yielding at the rate of 600 maunds to the acre.

Reports on the experiments of 1872-74.

68. Mr. Phillips' reports on his experiments in the years 1872, 1873, and 1874, are reproduced here. They prove conclusively the value of the Chinese sorgho as a forage plant, and its superiority over jowar; and the details of the experiments, which appear to have been very carefully carried out, will no doubt prove of interest.

"1872.—SORGHUM SACCHARATUM.—Last year, having in a great measure determined the superiority of the sorghum over the jowar without any artificial aid of deep-ploughing or manuring, it was determined this season to sow the sorghum on good soil, which had been deep-ploughed and manured, to ascertain the maximum yield of karbi which it would produce. For this purpose eight acres of land were reserved which had been under cotton, and had been deep-ploughed and manured for that crop. This year it was also lightly manured with bazaar sweepings, at the rate of 20 cartloads to the acre, and afterwards English-ploughed. The manuring and deep-ploughing has greatly improved the soil; and, although still light in texture, it has greatly improved it in body by incorporating the manure, soil, &c., together.

"The soil, after being English-ploughed, was twice ploughed by the native ploughs, and then planked, to level the soil; the seed was then sown at the rate of 10 lbs. per acre, from the 1st to the 9th of July, in drills two feet wide. The earliest sown having germinated evenly, was well up, and the rows quite distinct, by the 9th, the later sown seed advancing in growth in proportion. By the 19th the plants were nearly 9 inches high, when they had their first weeding; and by the 1st of August the plants were 2¼ feet high, and looked strong and healthy. At this time the native ploughs ploughed up between the rows, both for cleaning and loosening the soil round the roots of the plants.

"Some of the plants were also thinned out to one foot apart, and given to the farm bullocks; this greatly improved those plants which were left, by giving them more space and allowing the air to have a freer circulation about them; and being much stronger when they were cut, they naturally started into their second growth much freer than the others. It would have been very desirable to have thinned out the whole of the plants; but having no sale for the thinnings, and being unable to utilize them all, I considered that the excess of crop expected would not have covered the extra expenditure. During the whole of the month of August the plants grew very rapidly, and by the 31st were from 15 to 16 feet high and showing flower. We, however, could not get it cut soon enough for the second or third cuttings to be of any practical value. At the same time, there was a quantity of it used, as it was required, by the farm bullocks, and a small supply of 7½ maunds daily for the Commissariat, which, being early cut, again soon started into the second growth. By the 1st October the plants had reached their full height of from 18 to 19 feet, and on the 16th we had a demand for it from the Commissariat at the rate of 275 maunds per day till it was all cut. The actual amount of produce of karbi from the thinnings and first cuttings was, from the eight acres of land, 3,514 maunds, or just about 439 maunds per acre. The last of the crop was not cut till the end of October, and where late cut the second growth was of little or no consequence. However, one acre was cut in the month of August, which gave an outturn of 88 maunds of karbi when recut in the month of November; but even August was not soon enough to determine the actual outturn the plants were able to give, as they were from 12 to 14 feet high when cut, and they ought to have been cut when from 3 to 4 feet. One point worth noting is, that where the plants were cut early they started again vigorously from the old roots; but where they had nearly reached their full height when cut a great many of them did not start at all, and what did start took a considerable time. Those again which were left uncut till the seed was half ripe started naturally from the base of the stem and grew away with great vigour; and, had we only had the regular winter showers here, would certainly have produced a good second crop. As mentioned above, one acre was cut the second time, and the remainder was grazed on the field; however, by a close

calculation of several pieces cut and weighed, the average return of the second crop would be about 50 maunds per acre. This would raise the total number of maunds to 3,914 or an average of a little over 489 maunds (lbs. 39,020) per acre."

"1873.—SORGHUM SACCHARATUM.—The extent of land sown with sorghum this year was 27 acres; 13 acres of this was manured at the rate of about 300 maunds of bazaar sweepings per acre, and English-ploughed during the months of December and January and left turned up to the action of the sun and air during the whole of the hot weather. Seven acres were manured as above, but not English-ploughed until the month of June and the beginning of July; the remaining 7 acres were English-ploughed, unmanured, but manured last year for cotton. After being English-ploughed, the ground was twice ploughed by the native ploughs, and planked, as usual, to level and smooth the soil for sowing. In sowing, each piece of ground was divided, and half-sown in lines, and the other half broadcast. There was no appreciable difference in the outturn of either; however, in sowing broadcast, there is fear of sowing too thick, which puts you to the expense of thinning out the plants,—a work which scarcely repays itself; and at the same time, the broadcast system is more difficult to till than when it is sown in lines.

"The seed was sown, at the rate of 9 lbs. per acre, from the 11th to the 16th of July, one half in lines, or drills two feet apart, and the remainder broadcast. By the 14th the seeds were germinating freely, and by the 26th the plants had reached the height of about one foot, when they were hand-weeded and cleaned. On the 11th of August the plants were 18 inches high, and looked strong, healthy, and very even in the field; at this time we ploughed up between the plants with the native plough, to clean and loosen the soil round the plants.

"This practice of ploughing between the plants with the native ploughs is, I find, very beneficial, as it loosens the soil which has become hard and battered by the rains, and encourages the young roots to strike down to the freshly-stirred soil, the rapidity of growth after which is very great. By the 3rd of September, exactly seven weeks after sowing, the plants were 12 feet high, when the first cutting took place on the unmanured ground, which gave an outturn of 200 maunds (lbs. 16,000) of karbi per acre, which increased in the course of 6 days on the manured but late-ploughed ground to 258 maunds (20,640 lbs.); however, a part of each field, or experiment rather—as it was all grown on the one field, so that we might get the same sort of soil for each experiment,—was left till the month of November, when they were all cut within three days of one another, so that we might get a fair average of each piece.

"The English-ploughed unmanured ground gave at the rate of 352 maunds (lbs. 28,160)* per acre; English-ploughed in June and July, and manured at the rate of 300 maunds per acre, gave 440 maunds (lbs. 35,200);* and English-ploughed in December and January, and manured at the rate of 300 maunds per acre gave 535 maunds (lbs. 42,800),* or an average over the whole field, both in late and early cuttings, of 333 maunds 15 seers (lbs. 26,670)† per acre.

"The second cutting was of little or no consequence, as we had only one or two very slight showers of rain after the first cutting. This average would have been much greater, but the rain giving over so early the plants did not start into the second growth properly, and, where they did start, had not sufficient moisture to produce the second growth. The second and third cuttings which can be had from this crop may give you a continuous cutting when you require it in small quantities; but it does not give the same weight of karbi as where the plants are left to perfect the growth at once.‡ When cut, the plants in a manner lie dormant for some time, nearly three weeks, till once they begin to push the new shoots and recover their growth. Of course this is so much of the best of the rainy season lost; however, in a chance long rainy season, or where you have an unlimited supply of water, it might be different.

"*Jowar* (*Sorghum vulgare*).—Eleven acres of jowar were sown on land similar to the sorghum, manured and prepared in the same manner as done for the sorghum. The seed was sown broadcast from the 18th to the 23rd of July, and then lightly ploughed over by the native ploughs, to cover the seeds. By the 25th the seeds had germinated very regularly; the plants progressed favourably, were once weeded, and once native-ploughed between the plants, the same as the sorghum. The crop, however, was not cut till the 8th of October, when the growing plants are at their heaviest weight, *i.e.*, just when the plants are showing flower before they form the seed. The average weight per acre of karbi given being 307 maunds 18 seers (lbs. 24,596), to compare this with the sorghum, there is little difference in the average; but we must consider that a great part of the sorghum was cut when it was not half grown, and the want of late rain gave us no second cutting; and that this is rather the maximum weight of the jowar, while the maximum of the sorghum was 535 maunds (lbs. 42,800)."

"1874.—SORGHUM SACCHARATUM.—The amount of land reserved for this crop this season was 28½ acres. This was divided into the following experiments:—

"Three acres were sown alternately with three acres of jowar, to test and compare the value of sorghum and jowar as a fodder plant, to be cut at different stages of their growth;

---

* These are the yields from particular portions, which were left to perfect their growth, of each experiment.

† This is the average outturn from the whole sowing, reckoning all the cuttings.

The reason of the latter result being so much less than the others is that the second crops, on the remaining portions of the plots which were cut early, were lost owing to the want of rain, as Mr. Phillips explains in the next paragraph.

‡ Colonel Boddam did not find this to be the case in Bangalore; but the reproductive powers of sorgho doubtless vary much in different climates, and are greater in warm than in colder localities.

F. G. W.

two and a quarter acres were sown on poudrette-manured ground; and 23¼ acres were sown on ground manured with bazar sweepings, to test and compare as a fodder crop when highly cultivated, and compare the value and outturn of karbi from poudrette and bazar-manured ground.

"The land was prepared as in former years, being once English-ploughed and three times native-ploughed previous to being sown. The seed was sown from the 12th to the 24th of June and lightly ploughed over by the native ploughs to cover the seed, which germinated freely and well, and was cleaned and treated in the same way as in former years. Being cleaned and once native-ploughed between the plants, it will be seen from the table appended that the sorghum on the early-cut plot gave an outturn of 83 maunds 1 seer per acre more than the jowar, while on the second-cut plot it gave 34 maunds 39 seers. There was, however, on this plot, a hollow where the rain lodged, and where the plants grew very thin and weakly. This accounts for the smaller average than No. 1 plot. On No. 3 plot there were 130 maunds 12 seers extra; this, however, does not show the maximum outturn of the sorghum, although it shows the comparative outturn of each crop, *i.e.*, sorghum and jowar sown at the same time; but we must bear in mind that sorghum does best sown as early as possible in the season, while the jowar is always left till about three weeks or a month after the rain commences, and is found to succeed better than earlier. For instance, this season on the farm the earliest sown sorghum, which was sown on the 12th of June on the cotton ground, gave the large outturn of 625 maunds (50,000 lbs., or over 22 tons) per acre (this, however, is not shown separately in the table, as it formed no particular experiment), while the greatest amount of jowar karbi was from that sown latest, *i.e.*, on the 5th and 6th of July. The outturn of sorghum from the 2¼ acres sown on the poudrette ground was only 180 maunds (lbs. 14,400) per acre. This was owing to the fact of the ground being so hot and strong from the poudrette, which rather burned the plants; however, I see on the early-trenched poudrette ground, where it has had time to cool, the barley-crop looks most excellent and of great promise.

"The crops this year stand thus,—

	Maximum.		*Average.*	
	Mds. S.		Mds. S.	
Sorghum	... 625 0	per acre	... 383 37	per acre.
Jowar	... 362 37	per acre	... 313 23	per acre.

The maximum, in my opinion, shows the fairest balance between the crops, owing to the small return from the poudrette ground and the loss occasioned by the lodgment of rain in one of the acre plots, already referred to.

"Both crops gave the greatest outturn when cut rather early in the season, *i. e.*, about the beginning of October, the average falling off later. This was caused by the attacks of an insect, a kind of borer, which pierced the stems of the plants 6 or 7 feet from the ground; and, having very continuous wet weather at the time, the rain got entrance into the stem of the plants by the wound or hole made by the insect, and permeated right down through the soft cellular tissue of the plant to the ground, which blackened and caused it to rot. Otherwise, we would have had a much larger average from both crops. From this cause, also, we lost the second cutting this season, with the exception of about 3 acres of land that was sown on slightly rising ground, which kept the water from lodging so much about the roots of the plants, and which started into the second growth and gave an outturn of about 100 maunds per acre. The loss on the second cutting alone from this cause I estimate at about 2,000 maunds at the very lowest; this would have raised the average to about 455 maunds (lbs. 36,400) per acre. * * * The sorghum was not so soon attacked nor quite so bad as the jowar. I was informed by the Collector that the disease was quite prevalent throughout the district; and I believe the native cultivators have hardly been able to save as much seed as they require for sowing next season."

The following is the statement shewing the average results of the experimental cultivation of sorgho and jowar in 1874, referred to by Mr. Phillips in the foregoing:—

No. of experiment.	Name of crop.	Area in acres.	Nature and quantity of manure per acre.	Description of ploughing.	Date of sowing.	Date of reaping	Quantity of seed sown per acre.	Total yield of green forage per acre.	Total expenditure per acre, including rent of the land, Rs. 9-14-10.	Profit per acre.
							Seers.	Mds. S.	Rs. A. P.	Rs. A. P.
Plot No. 1 — 1	Sorghum ...	1	300 maunds of bazaar sweepings per acre.	English.	23rd June.	18th Sept.	6	215 10	15 7 7	6 0 9
Plot No. 1 — 2	Jowar ...	1	Ditto ...	Ditto.	Ditto.	Ditto.	7	132 9	15 7 7	2 4 1 (loss)
„ No. 2 — 3	Sorghum ...	1	Ditto ...	Ditto.	Ditto.	5th Oct.	6	335 29	15 7 7	17 1 7
„ No. 2 — 4	Jowar ...	1	Ditto ...	Ditto.	Ditto.	28th Sept.	7	290 30	15 7 7	13 9 5
„ No. 3 — 5	Sorghum ...	1	Ditto ...	Ditto.	Ditto.	19th Oct.	6	429 11	15 7 7	27 7 5
„ No. 3 — 6	Jowar ...	1	Ditto ...	Ditto.	Ditto.	20th Oct.	7	298 39	15 7 7	14 6 9
„ No. 4 — 7	Sorghum ...	2¼	Poudrette ...	Ditto.	24th June	23rd Sept.	6	180 0	15 7 7	2 8 5
„ No. 4 — 8	Sorghum ...	23¼	300 maunds of bazaar sweepings per acre.	Ditto.	13th to 22nd June	12th Aug.	6	412 9	15 7 7	34 2 11
„ No. 5 — 9	Jowar ...	9¼	Ditto ...	Ditto.	5th July	24th Oct.	7	363 37	15 10 4	20 12 3
„ No. 5 — 10	Jowar ...	1	Ditto ...	English (early).	6th July	21st Nov.	7	329 0	15 10 4	17 4 0
„ No. 6 — 11	Jowar ...	1	Ditto ...	Ditto late	Ditto.	22nd Nov.	7	239 0	15 10 4	8 4 0
„ No. 6 — 12	Jowar ...	1	Ditto ...	Native.	Ditto.	23rd Nov.	7	134 9	15 10 4	2 3 10 (loss)

Excepting in the experiment of 1871, Mr. Phillips did not say anything of the seed obtained from his experiments.

69. The soil on which the sorgho was grown at the farm was a sandy loam. It was described as of inferior quality but fairly suitable for a crop like sorgho; situation low, and the moisture from the rainy season above average. This moisture no doubt had much to do with the success of the experiments.

In the year 1874 Mr. Phillips had, as he mentions in his report above, an outturn from the sorgho of 50,000lbs., or 22 tons, of green forage to the acre, this forage, sold at the average rate of 7 maunds, or 560lbs. per rupee, giving a total of Rs. 89-5-5 for the crop. The cost of cultivating an acre of sorgho on the farm, including the rent of the land, being Rs. 15-7-7, the enormous profit of Rs. 74 per acre was thus realised.

Observations by Mr. W. S. Halsey.

70. In forwarding Mr. Phillips' reports for the year 1872, Mr. W. S. Halsey said that he had been cultivating sorgho himself for some years, and he had no doubt that it would grow and be a profitable fodder crop wherever jowar grows, provided that it is cultivated at the same season of the year, and in proximity to some large town where a sale could be got for fodder. He did not think that sorgho would ever get such a position in the districts as to interfere with the cultivation of jowar, as its value to the agriculturist, who, as a rule, does not grow fodder for his cattle, is not likely to be very apparent; and there is no such definite profit to be derived from it, either in the form of grain or sugar, as to induce the agriculturist to enter into what would be to him a speculative undertaking; but, on the other hand, Mr. Halsey said, in the large towns of the Upper Provinces there is always a large demand for fodder for the dairy cattle, and a large acreage of jowar is cut every year, when about 3 or 4 feet high, for sale in the towns. Mr. Halsey said, further, that the natives have a prejudice against commencing the use of jowar before a certain date, as, they say, if given too young, it is apt to produce diarrhœa; and this was one of the principal reasons why the Commissariat officer at Allahabad was averse to buying the sorgho as soon as Mr. Phillips wished to cut it. There is little or no foundation, however, for this belief. The farm cattle both at Allahabad and Cawnpore, Mr. Halsey said, besides his own cattle, had been in the habit of using the sorgho when young, and without suffering the least injurious effects.

Mr. Halsey thought that measures should be taken to have the plant cultivated for the Commissariat cattle in the neighbourhood of every large station for a couple of years; and he had little doubt that, if this were done, the natives who supply fodder for the cattle would very soon arrange for the supply without the Government keeping on the cultivation on its own account. Mr. Halsey was of opinion that, with an average rainfall, one cutting of the sorgho might be got off the ground in the early part of August (sowing in June), one towards the end of September, and another in November, leaving a portion of the field for seed. With three cuttings on fairly good soil, he said, and with an average rainfall, it would be a very profitable crop; and, what is of still greater importance, it requires no very special cultivation, or at any rate no such labour as involves capital. Mr. Halsey thought that it would be useless to attempt to cultivate sorgho except when the atmosphere is moist. He had tried it on the Cawnpore Farm with the assistance of canal water, but he found that it would never grow more than 3 feet high, and that it would come to seed at that height.

71. With regard to the current belief among the natives, mentioned by Mr. Halsey, that the young stalks of sorgho were injurious to cattle, Mr. Phillips said that all the bullocks on the farm had been fed from young plants which were thinned out when only one foot high, and that no evil results had followed from the practice. During the heavy and continuous rains, the plants, being very wet, relaxed the bowels of the bullocks a little, but this was easily counteracted by giving a little dry bhusa along with them. Mr. Phillips added that the sorgho was given to the bullocks from the time the plants were a foot high daily while it was in season, and that the bullocks liked it better and improved more on it than they did on any other kind of karbi, none of them, with the exception of those working with the English plough, getting any grain while they had sorgho. Mr. Phillips

Value of sorgho forage.

said that Major Lane of the Commissariat at Allahabad had a very high opinion of sorgho, having remarked that he had never seen the Commissariat bullocks improve so rapidly on any other kind of karbi as they did on the sorgho, and that he had been able to reduce their grain by one-half when they were fed upon it.

Experiments at Cawnpore and Bareilly.

72. Besides Mr. Phillips' experiments there have been none of any particular value in the North-Western Provinces, except at Cawnpore and Bareilly. At Cawnpore, an experiment upon one and a half acres of land yielded a profit of Rs. 68-9-5 above the expenses of cultivation and the rent of the land; no further particulars were given of this experiment. At Bareilly, experiments were made on a small scale by the Executive Commissariat Officer, who sowed seed according to the Chinese method in the beginning of April 1873. The young plants were transplanted when they were about four inches above the ground, and they were watered continually until the rains set in. The plants, which were in two different plots of 728 and 800 square yards, were cut in August and October, and yielded green fodder on the different plots, respectively, at the rates of 27,232 and 21,876 lbs. to the acre. No seed was taken as the plants appeared to be diseased just at the time of blossoming, and no second cutting could be got from the roots, which had been left in the ground for that purpose. The reason of this would appear to be that the first cutting was made too late. The sorgho grew to double the height of the indigenous jowar, and the stalks of most of the plants were more than an inch in diameter. The produce of the crop, indeed, the Commissariat Officer said, was twice as much as the produce of jowar or bajra would have been on the same soil.

Experiments on the Court of Wards' estates.

73. Some experiments with sorgho have lately been made in the estates under the charge of the Court of Wards in the North-Western Provinces. Mr. Buck, Director of Agriculture and Commerce, N.-W. Provinces, wrote in April 1876 of these experiments, as follows :—

"Seed was distributed to ten districts, with no very favourable results. But the Collector of Shahjehanpur reports that the cultivators on the estates where it was tried in his district took a liking to it, and wish to try it again. The Collector of Allahabad also wishes it to be tried again on his Court of Wards' estates. I consider that this method of giving the plant a trial, *i.e.*, by distribution in Court of Wards' estates is far the best that can be employed. Natives are the best judges of the merits of such a crop as sorgho, and their verdict should be taken as final after a sufficient number of trials. I propose for the next year or two to distribute seed, if procurable, more generally through the Court of Wards' estates, on the chance of the crop finding favour in other districts as it appears to have done in Shahjehanpur. Should it once gain a footing it will no doubt gradually extend in favour."

Oudh.

74. Sorgho has not been cultivated much in Oudh. A native at Lucknow was, in 1871, making experiments with the "red-seeded variety" (imphee) as a sugar plant, and seed from his stock was, early in 1872, distributed throughout the province for experiment to test the value of the plants produced for forage; but the only results reported were those obtained by Dr. Bonavia, the Superintendent of the Department of Science at Lucknow. No reports were made of the sowings by native cultivators who had received seed. Dr. Bonavia's experiments in the years 1874 and 1875, which are useful in showing the capabilities of the *imphee* as a forage crop, will be noticed in detail. The imphee (the "Otaheitan" variety of it), it may be mentioned here, is only superior to the Chinese sorgho in the property of yielding crystallised sugar; and, cultivated simply as a forage crop, it is scarcely to be compared to the Chinese sorgho, as Dr. Bonavia's experiments in comparison with the jowar tend to show. The Chinese sorgho, being a much larger plant than the imphee, is more productive of stalk and juice, and is consequently more profitable as a forage crop: care should therefore always be taken in sowing a crop of sorgho for forage to procure seeds of the *black-seeded* or original Chinese sorgho, as a sowing of any of the many various coloured seeds of the African imphees will not give nearly such good results. In all his experiments Dr. Bonavia adopted the native method of culture, on the ground that if the experiments were to have any practical value they should be conducted in a manner which is within the reach of the native cultivator.

Dr. Bonavia's experiments with the imphee.

75. In 1874, several small plots of ground, which had been under different crops and manured with different kinds of manure in the previous season, were sown with imphee. Dr. Bonavia did not use any manure, and the only practical difference between his cultivation of the crop and the cultivation ordinarily adopted by the natives, was that the soil of the different plots had been more heavily manured for the previous crops than is customary with them. The ground having been ploughed with the native implement, cleaned, and weeded once, seed was sown on different dates between the 7th June and 16th July on the different plots; all the seed germinated well. No irrigation was necessary as the fall of rain was very favourable throughout the season. The plants were, as a rule, three or four inches apart, and their height, which was much the same on all the plots, averaged from seven to eight feet. About six weeks after sowing the plants showed flower, and the canes were decidedly sweet. As Dr. Bonavia considered that in the process of seeding the saccharine matter would be transferred from the stem and deposited as starch in the seed, he, with a view of retaining the saccharine matter in the stem, cut off all the ears of the plants, excepting those of one of the plots which he reserved for seed. The yield of seed from this specially reserved plot was small, having been at the rate of 263lbs. per acre only, several of the ears having been found, on drying, to be without seed. Dr. Bonavia attributed this to the very early flowering of the imphee. The plants flowered about the middle of the rains, when the showers are heaviest, and thus each shower washed off a lot of pollen and prevented it from taking effect. The way to prevent this would be, obviously, to cut the crop early for fodder and leave the second or third growth for seed.

In the year 1874:

Of the remaining plots sown, four, aggregating one acre and nineteen perches, yielded green fodder respectively at the rates of 43,701lbs., 28,159lbs., 23,794lbs., and 19,466lbs. to the acre. The first of these, which is a very good yield indeed, was from a plot which had been under oats and heavily manured with city sweepings in the previous season; the second plot, which yielded at the rate of 28,159 lbs., had also been under oats, and heavily manured with wood-ashes and horse litter in the previous season; the third plot had been under tipári (*physalis edulis*) and slightly manured with night-soil, while the fourth, which yielded at the rate of 19,466lbs. to the acre, had no help from manure at all, the ground having lain fallow in the previous season. The forage was cut two months after the date of sowing the seed.

Yield of green forage.

Seven plots of ground, aggregating a little more than two-and-a-half acres, were left till the end of the rains to be cut for dry fodder, the yield of which was at the rate of 12,270lbs. per acre. The yield of dry fodder from the plot which was left for seed is included in this average. Dr. Bonavia was not able to cut the plants early for dry fodder, as the extreme wetness of the season would not admit of its being stacked; and he had to leave the whole of the plants he intended for dry fodder till the end of the rains. He did, however, cut one plot on the 16th August, with a view of ascertaining the height a second growth would attain; but the plants which sprung from the stubble only grew as high as three feet.

Yield of dry fodder.

An experiment was made in the same season with wood-ashes as a manure. A plot of ground was heavily manured with wood-ashes, but the experiment proved a failure, shewing, Dr. Bonavia thought, that mineral manures alone are not advantageous for sorgho.

All these experiments were made on what is commonly called *bhoor* (sandy and unproductive) land.

76. In 1875 experiments were made with imphee and jowar, to test the value of each as a forage crop. After the first rainfall two plots of ground, of 1,395 and 1,740 square yards, respectively, were sown on the 9th July with imphee and jowar. The cultivation was the same as in the previous year. No manure was used, but the ground had been well manured for the crops of the previous cold weather. The imphee plot had been under sugar beet manured with stable litter, and the jowar under annuals manured with wood-ashes and stable litter. All the seeds germinated well, and both crops grew very luxuriantly. On the imphee field the tallest plants were only six and a half feet high, and the

In the year 1875: imphee and jowar.

thickest of them measured 2½ inches in girth two feet from the ground. The tallest of the jowar plants averaged 12 feet high. The canes were thicker than those of the imphee, but, unlike the latter, they had no trace of sweetness in them. The tallest and thickest of the jowar plants were 2¾ inches in girth, two feet from the ground, and, Dr. Bonavia said, the whole field looked infinitely finer than the imphee.

One hundred and forty square yards of the imphee field, cut on the 3rd October, yielded 640lbs. of green folder, or at the rate of 22,125lbs. to the acre. The remaining portion of the field, 1,255 square yards, was left for seed and dry fodder, and it was cut when the seed was ripe, *viz.*, on the 30th November; and the yield was, in seed, 330lbs., or about 1,273lbs. per acre, and dry fodder 2,000lbs., or about 7,713lbs. to the acre.

One hundred and sixty-eight square yards of the jowar field, cut on the 5th October, yielded 1,440lbs. of green fodder, or at the rate of 41,486lbs. to the acre. The rest of the field, 1,572 square yards, cut when the seed was ripe, *viz.*, on the 20th of November, yielded 407lbs. of seed, or at the rate of 1,253lbs. per acre, and 4,000lbs. of dry fodder, or at the rate of 12,316lbs. per acre. Neither the imphee nor the jowar made any successful growth as a second crop.

77. The results of the imphee experiment, it will be observed, although good, are not to be compared with those of the jowar in regard to the yield of forage, the yield of grain from both crops being about the same. Dr. Bonavia, however, says that there are two kinds of jowar cultivated by the natives; one short, producing large ears, which is grown for its grain; and the other tall, producing small ears, grown for karbi; and that the kind which he grew in comparison with the imphee was the karbi-yielding one. The imphee, he remarked, had seeded very well in this experiment, having flowered in the intervals between heavy showers; but he was sure that, had the kind of jowar which the natives use for seed been sown, the yield from it would have been much larger than the imphee yield.

Dr. Bonavia's opinion of sorgho.

78. Dr. Bonavia gave his opinion of sorgho as follows:—

"After having given careful attention to the experiments made with sorgho, both during the last three or four years, and also in 1861 and 1862, I have no hesitation in stating that, whatever this crop may do in Southern India, whether the climate is warmer and damper, in Lucknow, at least, on soil such as we have in the Horticultural Garden, it has never produced a satisfactory *second* crop after the first cutting for green fodder. In addition, I do not think there can be any doubt which kind is most suited for Upper India, the Chinese jowar (sorgho) or the native jowar. I have never, under any circumstances, succeeded in growing sorgho more than 7 feet high or so, while jowar, under similar conditions, will grow to 12 feet; and, looking at the two crops side by side, the difference in favour of the jowar is surprising. It is true the sorgho is sweet, but the extra sweetness can hardly counterbalance, *cæteris paribus*, the great difference of extra weight in karbi of the jowar.

"If sorgho were sown in the hot weather before the rainfall it would, in my opinion, require a great deal of irrigation to give more than one good crop for fodder, and the manure must be very liberal, indeed. If it be sown at the commencement of the rains, and cut when 3 or 4 feet high, it may have time to give a second inferior crop of about the same height, when it will seed and grow no higher.

"As to seed, the sorgho flowers early,—that is, about the end of August or beginning of September, according as the commencement of the rains is early or late, the sowing being made at the commencement of the rains. This being usually the height of the rains, the sorgho pollen runs every risk of being washed off by heavy showers before it could take effect. Many of the seeds would therefore remain unfertilised, as happened in last year's experiment. The country jowar, on the contrary, begins to flower after the rains are over and during bright warm weather. Every seed, therefore, is almost sure to be fertilised. Under these circumstances, in my opinion, sorgho has little chance of competing with the native jowar, as the yield of karbi from the latter is much greater, and the seed-yield of sorgho is precarious."

Dr. Bonavia's opinion is by no means favourable, but if his experiments had been with the real Chinese sorgho, instead of the African imphee, the results would, doubtless, have been far different. The outturn from the jowar cultivated by Dr. Bonavia, both in seed and grain, is very high, indeed; and it is probable that the real Chinese sorgho if grown in Lucknow would give excellent results, and eclipse the jowar as it has done elsewhere.

Central Provinces.

79. Sorgho has not received much attention in the Central Provinces.

Experiments were made in 1859 and 1860 with the imphee, and those in the Chhindwara district turned out very successfully. The climate of Chhindwara seemed to be very well suited for the cultivation of the imphee, but, beyond the experiments referred to, nothing further seems to have been done with the plant, although these experiments proved it to make a very valuable fodder for cattle, while it was thought that from the flour contained in the seed excellent bread could be made.

None of the later experiments instituted on Colonel Boddam's memorandum were of any account. Seed was distributed to different officers, in the usual course, but no results followed.

The grain of sorgho is not saleable in the Central Provinces, and the natives there have the same prejudice against the use of its fodder when young as those of other parts of the country have. Captain MacDougall, the Secretary to the Agri-Horticultural Society at Nágpur, however, said the same on this point as Mr. Phillips of the Allahabad farm, and others, have done; he had not found it to have any ill effects on the cattle which he fed with it. The result of his experiments on this head, however, he remarked, would not overcome the long-standing ignorant prejudice which exists.

Experiments by the Commissariat Department.

80. Some experiments were undertaken by the Commissariat Department in the Central Provinces. In 1873, the Commissariat Officer at Saugor obtained from a sowing on ordinary soil a yield of 4,990lbs. of green forage from 733⅓ square yards of land, being at the rate of 32,934lbs. per acre. The greatest height attained by the plants was 11 feet. Another sowing was made in the following year, 1874. The object of the sowing in this year was to provide green food for some sick elephants,—not for the purpose of ascertaining the greatest yield sorgho was capable of giving. The seed was sown on the 1st February, on an area of 2,100 square yards of land manured with sheep and cattle dung and irrigated; and the crop, cut on the 23rd of May, gave an outturn of 162 maunds and 34 seers of green forage, being at the rate of 30,026lbs. per acre. No seed was taken. In the beginning of the next year, 1875, the Commissariat Department took the matter specially in hand, and expectations were formed of sorgho providing the greatly felt want of a substitute for free fodder for the Commissariat elephants. But, strangely enough, the experiments made during the year, in great contrast to the results obtained in 1873 and 1874, were a complete failure; so bad were they, indeed, that all further experimental sowing of sorgho at Saugor was ordered to be discontinued.

The failure of the first sowings in the year, which were made in the month of June, was attributed to the excessive and continuous rain, but no cause was assigned for the failure of the later sowings. There were also some experiments made at Jubbulpore and Pachmarhi during the year, but these were attended with the same want of success as those made at Saugor.

Hyderabad Assigned Districts.

81. Some seed of the imphee was sent to the Hyderabad Assigned Districts from Madras in 1859, and an attempt was made to express sugar from the stalks of the plants produced. The particulars of this experiment are not on record. No further attempt was made to cultivate sorgho in Berar until the year 1871, when on receipt of Colonel Boddam's memorandum, experiments were made to test the value of the Chinese sorgho as a forage plant. Seed was not, however, received until the month of July, and it was not sown till the beginning of August. This, coupled with the remarkable scarcity of rain, which made the season a very unfavourable one for growing crops like sorgho, was the reason assigned for the indifferent results obtained from the experiments; but the opinions formed by the different officers who conducted the experiments, regarding the value of the crop for forage, were very favourable, and it was thought that in an ordinary year sorgho would thrive well in Berar, the climate of which was considered suited to its growth.

The Resident was very strongly impressed with the importance of sorgho cultivation, and he proposed to make further experiments in the following year; but no further attempts had, up to the end of 1874, been made to cultivate the plant in Berar.

The Punjab.

82. In 1859 seed of the imphee and the Chinese sorgho was received from Madras and distributed in all the divisions of the Punjab to be sown experimentally. The reports on the sowings in that year were highly satisfactory; the seed was said to be popular with the natives, the juice was plentiful, and the goor made from it good.

The experiment was tried again in 1860 and 1861, and it was noted that the seed raised in the Punjab during 1859 and 1860 stood drought better than new seed received from Madras. In 1860 the experiments in some of the districts were a great success; but the results were not so good in the next year, the experiments in some districts being a failure without any assignable cause; and it was thought by some of the officers who conducted the experiments that the plant had degenerated. On the other hand, the experiments in a few of the other districts were a marked success. The seed in each case was sown with the khurreef, or spring sowings. The results in each year during the three years of experiment were generally worse than those of the preceding year, but in 1862 a further experiment made at Lahore was completely successful. The following is an extract from the Summary to the Punjab Revenue Report of 1862-63 on the subject:—

"Sowings of imphee and China sugarcane appear to be here and there still cultivated with some success, where officers have taken a special interest in the matter. But the reports, generally speaking, are unfavourable, and the cultivating classes do not seem to approve of or care for the plant."

Results of experiments in 1873.

83. In the year 1873 seed was again distributed throughout the different districts for experimental sowing. The experiments made were all, however, on a very limited scale, and only general results were furnished, detailed information regarding the yield and cost of cultivation not, in many cases, being supplied. But the reports from the different districts tended to show that when sorgho was grown on manured and irrigated land it was superior to the indigenous jowar cultivated under the same circumstances, and that it would produce a good crop of excellent fodder which was much relished by cattle. The best results obtained were from the experiments made in the Delhi, Sirsa, Umballa, Siálkot, Gujrát, and Dera Gházi Khan Districts.

The expense of cultivating sorgho was thought to be greater than the expense of cultivating jowar, but the sorgho was acknowledged to produce a more valuable crop both for fodder and grain than the jowar, and in many cases the yield in weight of the produce was greater. The native cultivators in the Punjab wrongly thought that the sorgho stalks were not so well suited for fodder as jowar stalks, on account of their thickness. Mr. Halsey of Amritsar, who had made frequent experiments with sorgho in the Punjab, said that he had found it a better crop than jowar, both for forage and grain, and that it was equally well suited to the climate of the Punjab as the jowar.

Experiments by the Commissariat Department.

84. Experiments on a large scale were made by the Commissariat Department. The experiments conducted by the Commissariat Officers at Umballa, Jullundur, and Ráwalpindi were very encouraging, while those at Ferozepore, Peshâwar, Meean Meer, and Mooltan turned out badly. In Mooltan most of the plants were destroyed by drought, but others which were sheltered by some adjacent trees grew to the height of 12 feet, and the Commissariat Officer thought that sorgho could be grown with advantage in Mooltan as the land is irrigated by the canal.

Umballa.

In the experiments at Umballa, the first sowing was made on the 10th of June 1874, the quantity of seed sown being 9 tolas in weight, on a plot of ground of 273 square yards or rather more than the eighteenth part of an acre. The ground had been previously trenched about 3 feet, and it was manured with black earth: 7 seers of saltpetre were also added.

The planting and cultivation were carried out in accordance with the directions for growing sorgho in the Mysore Province given by Colonel Boddam. As the rains had not come on at the time of planting, and did not do so till about three weeks after, it was necessary to irrigate for that period, during which time the young plants throve remarkably well, and became strong and healthy canes of about 4 feet high before the first burst of the monsoon; they

continued to grow with great rapidity, and the first cutting was made in the latter part of July (on the 28th and 29th), when the side shoots, of which there were an average of two to each plant, were cut, and yielded 20 maunds and 20 seers of green forage. These side shoots, the Commissariat Officer said, formed most nutritious succulent fodder of first-rate description, suitable for elephants or any other kind of cattle.

The leading shoots were allowed to remain till the 19th September, for the purpose of collecting the seed, and about the 10th September some 15lbs. of seed were found to be ready and were collected; a quantity of seed remained, but it was not sufficiently advanced to gather, and as it was ripening during the rains it was dispersed and destroyed by a heavy storm which took place.

The remainder of this patch, consisting of the main shoots, was then cut on the 19th December, and yielded 25 maunds and 35 seers of green forage. After the first side shoots were cut, no others sprouted or were sent out by the plants for successive cutting as Colonel Boddam said would be the case. The total outturn of fodder from the experiment was 3,816lbs., equivalent to about 67,653lbs., or a little more than 30 tons, of green forage per acre. The quantity of seed obtained was only 15lbs., or at the rate of about 266lbs per acre; but this was owing to the causes stated above, and also to the attacks of birds, which made great havoc with the seed while it was ripening. The height attained by the plants was from 16 to 18 feet.

A second sowing made at Umballa, later in the year, was a partial failure owing to heavy storms which came on soon after the seed was sown. The Commissariat Officer thought that the proper time for sowing sorgho would be the end of May or beginning of June, so that the plants might become strong enough to resist the first burst of the monsoon.

Jullundur.

85. The Executive Commissariat Officer at Jullundur had a few seeds sown in October 1873, but he found that seeds sown in the month of March following were ready for transplanting as soon as those sown in October. He concluded from this that sorgho is a hot-weather plant, and would not grow in the Punjab in the cold weather. Again, of small quantities of seed sown in February, March, and April 1874, the seed sown in April was found to be ready for cutting as soon as that sown in either of the two preceding months. Further, the old roots left in the ground after the cutting of a former crop were transplanted in fresh ground, and yielded a much heavier crop than that grown from fresh seed; and the Commissariat Officer drew from this that, where seeds were difficult to procure owing to the destruction of birds, the roots of former cuttings would make a good substitute for sowing a crop. Five and a half acres of land were under cultivation in these experiments. The seed had been sown at the rate of 2 or 3lbs. only, to the acre, and the yield per acre was 33,040 lbs. of green fodder, cut three times during the season, *viz.*, in July, August, and October.

Ráwalpindi.

86. The Executive Commissariat Officer at Ráwalpindi had a portion of the seed with which he had been supplied sown on the 22nd April 1874. He sowed in drills 26 inches apart, and at the rate of 20 seeds per foot, subsequently watering the young plants according to Colonel Boddam's directions; but no saltpetre was used.

At the end of June the crop was thinned by cutting the side shoots, and on the 22nd August, *i. e.*, four months after sowing the seed, the crop was cut. The area of the land was 136 square yards, and the yield was 17 maunds and 15 seers of green fodder and 7lbs. of seed, being at the rate of 49,467lbs., or over 22 tons of fodder, and 250lbs. of seed per acre. The greatest height attained by the plants was from 13½ to 14 feet. As the crop was sown so early in the season it had to be frequently irrigated.

The remainder of the seed was sown on the 23rd of June on a plot of 50 square yards, and yielded, according to the return made, 12⅓ maunds of fodder and 13lbs. of seed, being at the extraordinary rate of 96,800lbs. or over 43 tons, of green forage, and 1,258lbs. of seed to the acre. It is probable that there is a mistake in this return, which shews a higher yield of green forage even than the maximum obtained in the United States. About the sixth part of the crop had been cut in August as thinnings; the rest was not cut until the 2nd of October. The land on which the crop was grown had been long under cultivation, and was well looked after and manured.

The Commissariat Officer was of opinion that, to admit of satisfactory and trustworthy results, sowings of sorgho should be made on a much larger scale than it is in the power of any ordinary Commissariat Executive to carry out, and that the most suitable place to select would be one where at least 10 acres of ground could be planted out, and where plenty of water would be available.

Other experiments.

87. Further experiments were made, under the orders of the Financial Commissioner in the Punjab, during the year 1875. The season in this year was a most unusual one, and extremely unfavourable for experiments intended to show the comparative value of a new staple, but very good results were obtained in the Siálkot, Mooltan, and Jhang districts, and on the Government farm at Amritsar.

In Siálkot, two plots of ground, each 1 rood and 20 perches in extent, were sown on the 12th June with seed at the rate of 4 seers per acre, and yielded at highly satisfactory rates.

The experiments were thus described :—

"*1st plot.*—The Chinese method of culture was adopted. The plants were grown in Indian corn soil which was previously well watered and manured. The plants in this plot were kept for seed and were allowed to mature.

"They grew splendidly, attaining an average height of 16 feet. The greater part of the seed, however, was destroyed by the heavy rain and birds, and only 10 seers of good seed were collected.

"*2nd plot.*—The seed was sown in good soil and the ground kept moist until the plants were a foot high, when they were planted out in their permanent beds in rows about 2 feet apart and a foot from plant to plant. When put down the plants were watered, and then until the setting in of the rains, early in August, they were watered every fourth or fifth day. Weeds were kept down by frequent hoeings. This plot was kept for supplying fodder for the Government garden cattle. On the 28th July the side shoots were cut and then again, when the plants were just about seeding, they were cut down to a foot. They then threw out fresh shoots, which were cut towards the end of October. Thus a continuous supply of fodder was obtained for nearly 3 months, and at a time when no other kind of green fodder could be had. It is clear that sorgho is the most profitable of all the crops sown at the same season."

Some seeds of sorgho sown in the Jail Garden at Mooltan, on canal irrigated land which had been well manured, yielded at the rate of 170¾ maunds (13,660 lbs.) of fodder (not stated as green or dry), and 19 seers of seed per acre. The value of this outturn, as compared with jowar, was given as follows :—

Sorgho.	Rs.	A.	P.	Jowar.	Rs.	A.	P.
Seed, 19 seers, at Re. 1-9 per maund ...	0	11	11	Seed, 8 maunds, at Re. 1-4 per maund ...	10	0	0
Fodder, 170 maunds, at Rs. 20 per 100 maunds	34	0	0	Fodder, 80 maunds, at Rs. 20 per 100 maunds	16	0	0
	34	11	11		26	0	0

Sowings of seed in two other gardens, on land similarly prepared, yielded equally good results.

A sowing in Jhang on the 2nd May yielded 560 maunds (46,800lbs.) of green fodder per acre, a sowing of jowar at the same time yielding 588 maunds (47,040lbs).

An experiment on one acre of land at the Amritsar Government Farm yielded 240 maunds (19,200lbs.) of green fodder, which was valued at Rs. 19, the value of the yield on the farm from an acre of jowar being Rs. 12, and of bajra Rs. 9-8, the cost of cultivation being the same for each crop.

In most of the other districts in the Punjab the experiments turned out badly, owing to the excessive rain and the floods which occurred in the months of August and September; better results, however, were obtained in the several districts in the Mooltan and Derajat Divisions, where the season was more favourable. The experiments will still be persevered in in the Punjab, where the value of sorgho was fully appreciated by the late Financial Commissioner. Most of the experiments carried out in 1875 were made with a view to the collection of seed for future experiments, and this is one reason for their partial failure, as sorgho always gives the best results when cultivated for forage. The conclusions drawn by the Financial Commissioner from the experiments of 1875 were as follows;—

"(*a.*) The crop will bear, and indeed requires, to be cut down repeatedly when it is intended for fodder. The Deputy Commissioner of Shahpur appears to think that the crop may be cut down once or twice with advantage, even when it is intended for grain. The

Financial Commissioner believes that it is not usual to cut down in their earlier stages jowar and bajra crops—the indigenous varieties, to which sorgho is most nearly allied—which are intended for grain. It will be interesting to see whether sorgho, which undoubtedly possesses more vitality than either jowar or bajra, can be cut down once or oftener in its earlier stages, and yet give a fair yield of grain.

"(*b.*) It would appear that, where the crop is intended for grain and not for fodder, and is not to be interfered with till the grain ripens, the seed should not be sown till the end of June or the beginning of July.

"(*c.*) It appears that if the crop is left too long uncut, and especially if exposed to much rain, it is liable to turn black and rot."

Yields of seed and fodder.

88. A table is appended shewing at a glance all the different yields obtained, both of seed and fodder, from the experiments in India, compared with the usual yields in the United States of America, France, and Algeria. The largest yields of green fodder in India were those at Umballa and Ráwalpindi noted on page 36. The other large yields, over 30,000lbs., were those obtained at Húnsúr, the Botanical Gardens at Gunesh Khind in Bombay, the Model Farm at Salarú in Sind, Deesa, the Allahabad Farm, Lucknow, Saugor, Jullundur, Ráwalpindi, and Jhang.

Sorgho has thus succeeded much better in Northern India than it has done in the Madras Presidency and Mysore, where the highest yields obtained—excepting that of 47,190lbs. on the Cattle Farm at Húnsúr, which was produced under very exceptional circumstances—weighed per acre 21,108, 20,000 (in Mr. Robertson's experiments at the Sydapet Farm), 26,880, and 20,160lbs. (in Colonel Boddam's experiments). The highest yields of green fodder obtained from the jowar cultivated in Northern India for purposes of comparison with the sorgho experiments were 41,486lbs. at Lucknow and 47,040lbs. at Jhang as noted on pages 32 and 37.

Yields per acre of seed and fodder from Sorgho cultivated in the United States of America, France, Algeria, and India.

Page of the Note.	Yields.	Seed.	Fodder	
			Green.	Dry.
		lbs.	lbs.	lbs.
11	United States .. .. From ...	900	15,700	4,500
	... To ...	1,800	89,600	20,200
	South of France ... ... Has reached ...	2,160	...	...
	Algeria ... ... Ditto ...	...	...	22,400
	India—			
14	Mr. Robertson's experiments at Sydapet	1,689	21,108	...
15	Ditto ditto	...	20,000	...
20	Colonel Boddam's experiments at Bangalore	470	13,144	...
21	Ditto ditto	601	26,880	...
	Ditto ditto	...	20,160	...
20	Experiment on the Cattle Farm at Húnsúr	1,498	47,190	...
22	Experiment at the Lál Bagh in Bangalore	825	11,200*	
	Experiments at the Gunesh Khind Botanical Gardens, Bombay ...	...	22,400	8,960
	Ditto ditto ...	...	24,640	9,856
	Ditto ditto ...	...	25,760	10,304
	Ditto ditto ...	...	31,360	12,544
	Ditto ditto ...	280	...	1,344
23	Experiments on the Model Farm at Salaru, Sind	32	13,033	...
	Ditto ditto	936	9,774	...
	Ditto ditto	...	38,420	...
	Ditto ditto	...	3,279	...
24	Experiment at Deesa	219	32,680	...
	Ditto at the Botanical Gardens, Calcutta	...	27,311	...
26	Ditto on the Government Farm at Allahabad	409	16,880	...
27	Ditto ditto	...	39,020	...
28	Ditto ditto	...	42,800	...
	Ditto ditto	...	50,060	...
31	Ditto at Bareilly	...	27,232	...
	Ditto	...	21,876	...
32	Ditto by Dr. Bonavia at Lucknow	263	...	...
	Ditto ditto	...	43,701	...
	Ditto ditto	...	28,159	...
	Ditto ditto	..	23,794	...
	Ditto ditto	...	19,466	...

* Not stated as green or dry.

Yields per acre of seed and fodder from Sorgho cultivated in the United States of America, France, Algeria, and India—(continued).

Page of the note.	Yields.	Seed.	Fodder.	
			Green.	Dry.
		lbs.	lbs.	lbs.
	India—*continued.*			
32	Experiments by Dr. Bonavia at Lucknow	...	...	12,270
	Ditto ditto	...	32,128	...
	Ditto *ditto	1,273	...	7,713
34	Ditto at Saugor in the Central Provinces	...	32,934	...
	Ditto ditto	...	30,026	...
36	Ditto at Umballa	266	67,653	...
	Ditto Jullundur	..	33,040	...
	Ditto Rawalpindi	250	49,467	...
	Ditto ditto	1,258	96,800	...
37	Ditto at Mooltan	...	13,660*	
	Ditto at Jhang	...	46,800	...
	Ditto at Amritsar	...	19,200	...

General results of sorgho cultivation in India.

89. The experiments that have been made in India prove that sorgho will grow and thrive in any part of the country; and that if brought under general cultivation the advantage in affording nourishment to cattle and improving their condition would be great. As in other cases, however, the cultivation has not been allowed to pass beyond the experimental stage. Sorgho has been proved to be an excellent forage plant, and to have special advantages over other plants which are usually cultivated for forage in the country, but it has not been taken to by the natives. All the experiments recorded in this note were made by Europeans, or under European supervision, there having been scarcely a single experiment made by the natives that has turned out of any value, although seed has been widely distributed among them. This cannot be held to reflect upon the value of the crop, as the apathy and indifference of the natives in regard to anything that is new, and especially in the way of agriculture, is well known; and this, besides, is the experience undergone more or less by every plant that has been introduced into the country. Colonel Boddam was fearful of this fate overtaking the sorgho, as will be seen from the following extract from his report on the results of his deputation to Mysore:—

"I recommend sorgho as an important addition to the forage crops of Mysore, but deprecate desultory experiments, or it may share the fate of many other trials so conducted. Seeds of various kinds have over and over again been distributed for trial in small quantities to District Officers, and handed over to the Amildars, who are apathetic and ignorant in agricultural matters (I state this on the authority of letters from District Officers). No good has ever come of such experiments."

Colonel Boddam thought that experiments should be undertaken on a large scale under European supervision, as the only means of attracting the attention of the natives to sorgho; and a very good suggestion, apparently, and one which the Government might think worthy of consideration, is that which has been made by some of the officers who have experimented with sorgho, *viz.*, that the crop should be persistently cultivated on the Government farms and by the Commissariat Department for some years together, when the subject would be brought practically and forcibly to the notice of the native cultivators; and this really appears to be the only means of inducing them to take an interest in sorgho cultivation. The cultivation of sorgho has been undertaken systematically by the Government of the Punjab. Experiments are annually being made in the Government and jail gardens, and a stock of acclimatised seed is from this source made available and kept for distribution to any who may ask for it.

90. Sorgho does best in India in moist climates, although it is hardy enough to grow almost anywhere; and it has been found that irrigation is necessary for a good crop wherever rain is not plentiful. Sorgho will do well without much manure, and on poor soils, but with manure and water it comes to great perfection and is a highly profitable crop. It is a good crop under the most ordinary cultivation, and it can be cultivated exactly as jowar

* Not stated as green or dry.

is by the natives. It very closely resembles the jowar in habit and growth, and should be cultivated at the same time of the year and under the same conditions as that crop is, any additional care that may be bestowed upon it in cultivation being repaid by a large increase in the yield. The seed will germinate in India almost at any time, but the best time for sowing has been found to be May or June, and, if grown as a cold-weather crop, October. If cultivated only for forage, it appears that sorgho is one of the very best crops that can be grown in India, and superior to the jowar, but its yield of grain is not so certain or usually so large as that of the jowar, and this has been given as a reason for sorgho not having found favour with the natives in many districts.

91. Sorgho forage has very generally been admitted to be superior in nutritive qualities to either jowar or bajra forage, but there have been very many instances in which it has fetched a lower price than the ordinary karbi, the natives being suspicious of it and not caring to use it, on account of its being new and unknown to them. Sorgho seed is now valued on the Sydapet Farm at 9½ pies per lb., the seed of the yellow and white cholum, the rivals of sorgho in the Madras Presidency, being valued at 5 pies and 6 pies per lb., respectively. The Seed sells in England at from 1*s.* to 2*s.* 6*d.* per lb., and in Australia at 6*d.* per lb. Seed has been regularly distributed to applicants by the Superintendent of the farm, who, on the 31st March 1875, had 7,298lbs. in stock for distribution. Some officers who have made experiments found sorgho plants to deteriorate after two or three years' cultivation: this may be attributed in many cases to hybridization with the common jowar, to which the sorgho is very apt: sowings of strange seed, too, will doubtless have a tendency to produce the same result, so that it is of importance to obtain, if possible, seed that has been acclimatised for sowing in particular districts.

92. The extreme sweetness of the sorgho stalks renders them liable to the attacks of insects, and this is certainly an objection to the crop. The seed, too, is sometimes liable to be attacked by a weevil if kept through the rainy season. Birds are very fond of the seeds, and will rob a whole crop of its seed if proper care is not taken to prevent them.

Many attempts have been made in India to extract sugar from the imphee. *Goor* has frequently been made, both by European and native experimenters; but, owing chiefly to want of care in its manufacture, this *goor* has generally been of inferior quality and of less value in the market than the ordinary sugar-cane goor. Crystallised sugar does not appear to have been made from the imphee at all, to any extent, in India. These failures in sugar-making may, perhaps, be attributed, in part, to the probability of the best saccharine kinds not having been among the six varieties of the imphee originally imported from the Cape of Good Hope into Madras. No information on this head was sent along with the seeds from the Cape. In some experiments made in Bombay in the year 1860, one bigah (of 2,500 square yards) of land yielded 500lbs. of *goor*, which was obtained in one hundred days after sowing the seed, the yield of seed when the crop was grown for sugar having been about half that of the common jowar. In some experiments made in Madras, also, good results were realised; and it was reported that cattle readily eat the stalks of the sorgho after the sugar had been extracted from them. This, indeed, has been found to be the case in America. There does not appear to be any reason why good *goor* should not be made from the Chinese sorgho and the imphee (the red-seeded "Otaheitan" variety particularly) in India. These plants coming to maturity in from 3 to 4 months, while the sugarcane takes usually from 12 to 14 months, their being much easier of cultivation and their stalks being much softer and more easy to crush than those of the sugarcane, give them an advantage over the ordinary cane that might well be turned to account. The value of sorgho as a forage plant is, however, its principal recommendation for India; and the Chinese sorgho, or what is generally known as the "tall black-seeded variety," if its cultivation is energetically taken up, has a great future before it as one of the best forage plants of the country. If sown early it will yield a supply of fodder for use during the hot months when every other kind of grass is dried up, and during the rainy season; and if cut when from three to four feet high it will shoot up again, giving three and even four cuttings from one sowing, a stock of seed for sowing in the following season being obtainable from the latest growth of the plants.

F. G. WIGLEY.

Calcutta, May 1st, 1877.

1877.

GOVERNMENT OF INDIA.

DEPARTMENT OF REVENUE,
AGRICULTURE, AND COMMERCE.

AGRICULTURE and HORTICULTURE.

NOTE ON SORGHO

(SORGHUM SACCHARATUM).

BY

F. G. WIGLEY.

Government Central Press.—No. 1355, R. A. & C.—11-5-77 —500.

THE CAROB TREE

(*CERATONIA SILIQUA*),

WITH REFERENCE TO ITS CULTIVATION IN INDIA.

---

1. THE *Ceratonia siliqua*, a member of the natural order Leguminosæ, sub-order Cæsalpiniæ, and a rather close ally of the Indian tamarind, is extensively grown on the shores of the Levant, in Turkey in Asia and the island of Cyprus, on the Mediterranean Coasts, both African and European, in Italy, the islands of Sardinia and Malta, and Spain, its culture being particularly extended in Southern Italy and Sicily. In Cyprus it grows wild, and is very abundant. Some of the cultivated Cyprus varieties are held in great esteem as the best existing varieties of the tree. Growing in most soils, and not requiring much moisture or care, it gives but little trouble, and its cultivation is extending in the island every year. The yield of fruit, however, is affected in hot and dry seasons, the quantity being comparatively small and the quality inferior. The bean is exported from Cyprus chiefly to the Russian ports of the Black Sea. The tree also grows in great abundance in Palestine, whence the bean is exported to Alexandria and Constantinople.

2. The synonymes of the tree are: Spanish, Algarroba; Portuguese, Algorroba; Italian, Carrubio and Caruba; German, Karob-baum and Johannisbrodbaum; English, Carob, Locust bean, and St. John's bread. The German and English reference to the apostle is derived from the idea that these beans were the "locusts" on which, as the Scriptures say, he fed in the wilderness. In Greek, Balfour tells us (*Class Book of Botany*), the tree is called Keratia or Keratonia, and he adds that in Luke xv., 16, the word Keratim, which has been translated 'husks,' is taken to mean the fruit of the Carob tree. This conjecture of Professor Balfour is supported by the opinion of Archbishop Trench (from whom perhaps Balfour adopted the view he has expressed), in his *Notes on the Parables*, where it is said that these husks are "the fruit of the Carob tree."

3. The other name of the tree clearly comes through the Spanish from the Arabic name of the tree *Kharoub* or *al Kharoub*. In India it is known by the Arabic name, and is also sold in the bazaars under the name Kharnub Nubti and Kharnub Shámi, or Syrian Kharnub, seemingly a corruption of the Arabic word.

4. The tree bears a thick, flat, brown curved pod, containing hard red seeds resembling those of the tamarind, embedded in a red fibrous pulp of sweet and somewhat astringent taste. These seeds are said to have been the original carat weight of jewellers. The pulp, which is very nutritious and gently aperient, is the useful part of the tree. The crop is very abundant, trees sometimes yielding from 800 to 900lbs of pods. In countries where the tree is grown it is used for human consumption, especially in times of scarcity,* and at all times forms a nourishing, palatable and fattening food for horses, mules, asses, and horned cattle. "The plant, seeking its nourishment under ground,

---

* In his Commercial Report on Cyprus for 1873, a year of great distress in the island, the British Consul writes:—"Great numbers of the quasi-starving peasants were obliged to subsist on the edible roots [illegible] ous plants as they could dig up in the fields, using also locust beans to a large extent in lieu of cereals."

is so independent of surface irrigation and so retentive of life, that, according to M. Bové, a tree supposed to be three hundred years old, which was cut down during the French invasion of Egypt, sprang up again thirty years after on wells being sunk in its neighbourhood." *(Voigt. Hort. Sub. Cal.)*

5. The bean is now largely imported into England, where it is made up with oil-cake into food for cattle. Morton, in his Cyclopædia of Agriculture, speaks favourably of it as cattle food, and it is said that it forms one of the principal ingredients of the well-known "Thorley's food." The pulp is also said to be chewed by singers to improve the voice. The Turks make use of the pulp for sherbet, as the people of India do with tamarind pulp, mixing it with liquorice root and fruits. The bark is sometimes employed as a substitute for oak bark in tanning hides, and an invention has been patented at Paris for the application of the beans to the production of a species of glucose or fermentable sugar adapted to a variety of manufacturing purposes.*

6. In India it is held in repute as an astringent, and is employed in cases of cough accompanied with much expectoration. It is imported for medicinal purposes from Kabul, and is sold as high as Rs. 10 the seer in the markets. It is not as yet used for food, as indeed is sufficiently manifest from this extremely high price. In Cyprus £4-10 per ton is considered a high price and much above the average: the Indian price is equivalent to a rate of £1,220 per ton.

7. The history of the introduction of this tree into India greatly resembles the history of the experiments made with many other useful vegetable productions. The process has generally been somewhat as follows: The article is first lauded as a most useful thing, and its acclimatisation declared to be most desirable. Then there is a lull. A little later, some official, or perhaps some non-official gentleman, with a taste for these matters, sees the plant growing in some favourable locality, is struck with its appearance, introduces it with more or less success, and then leaves the district or the country, and the subject drops out of sight with him. A little later, the whole process is gone through again, and so on *da capo*, the very slightest reference, if any, being made by each successive experimenter to the results of the trials made before his time. Thus the experiment, which might, if carefully watched, finally shew in two or three years whether it was worth pursuing or not, drags on its weary course through thirty and forty years with indecisive results at last. The moral of the story is, that such experiments should be carried out in suitable conditions under the close supervision of a central Government department, charged especially with such business and competent to undertake it.

8. The main fields of experiment with the *Ceratonia siliqua* have been in the North-Western Provinces, the Punjab, and Madras.

In the North-Western Provinces its introduction dates as far back as 1840, having been recommended by Professor Lindley, through Dr. Royle. In that year the Superintendent of the Saharunpore Garden reported to Government that several hundred plants had been raised for eventual distribution along the dry and sandy tracts of those provinces. He stated that at that time the pods were selling in the markets at Rs. 10 the seer.†

Apparently the experiment came to nothing after all, for twenty-two years later the Superintendent of the Gardens, Dr. Jameson, reported to Government that he had *en route* to England visited Malta, and had been much struck with the growth of this tree in the most barren, dry, and stony places, and with its useful qualities, which he thus detailed: "It seeds immensely. By the poorer classes it is ground and mixed with grain, and when baked in the oven it is anything but disagreeable. In seasons of scarcity it is therefore much used by the poorer inhabitants. It is constantly given to horses and mules in the proportion of one measure carob beans to two measures of barley, and on this food they both work and thrive well." Dr. Jameson accordingly brought with him a large quantity of seed, from which he raised a number of plants to test the value of the tree "in the dry places of the North-Western Provinces." ‡

---

* Ure's Dictionary of Arts, Manufactures and Mines, ed. 1872.

† This statement I find repeated in various successive papers, including that most useful book, Mr. Baden-Powell's Punjab Products. Apparently the import of the article as a drug is small, and the price is not subject to great variation.

‡ Letter to the Government of the North-Western Provinces, No. 318, dated 26th May 1862.

In the following year (1863) he reported that the tree had been extensively propagated and distributed, but had not, though it flourished well, yielded pods in such quantity as in Malta and Italy. This, however, he said, might be due to the trees being too young. This remark I am unable to understand if Dr. Jameson referred to the produce of the seed of the previous year, for the tree never fruits until it is seven years old at least.

In the next year (1864) no reference was made in Dr. Jameson's report to these trees, but two cases of seeds are mentioned as having been received from the India Office, placing the Superintendent in a position to distribute the tree largely throughout the North-Western Provinces.

From this time down to 1872 official records, as far as I can ascertain, are silent on the subject of this experiment. In that year, however, we find it stated that many trees (among them the carob) had been raised from seeds received from the India Office and naturalised in the plains of the North-Western Provinces.

9. In 1862 Mr. G. Ricketts, C.S., of Allahabad, brought seed with him to India and sowed some at Benares and Cawnpore. One of the trees grown at Benares was afterwards removed to Cawnpore, where it grew extremely well, standing the climate perfectly. In 1873, when Mr. Ricketts saw it, the tree was nearly 25 feet high and 9 inches in diameter.

10. The latest experiment in the North-Western Provinces was tried with some seed presented to the local Government in August 1874 by Mr. W. S. Halsey, C.S.; most of the seed was sent to the Superintendent of the Botanical Gardens at Saharunpore, with instructions to give the plant all possible chances of successful growth. Of the progress of this experiment we have no account.

Some of the seed was also sent to the Commissioner of Kumaun for trial, and by him was distributed to gentlemen whom he thought likely to take an interest in the experiment. Some of the seed, the Commissioner reported, germinated freely at Haldwani, and he proposes to try whether the tree will mature in the severer climate of the Bhabur. This is unlikely, for, as the Secretary remarks, the climate of Kumaun is too cold for it. This is clear from the fact reported by the Commissioner that some plants which germinated in 1873 were in March last only a foot high. Kumaun is not a good locality for this tree.

11. In the Punjab the tree seems to have been introduced by Mr. Charles Gubbins, C.S., between 1842 and 1844. He imported considerable quantities of seed from Italy, and sowed it in the districts of Panipat, Gurgaon, Rohtak, and Delhi, also distributing seed to natives. In 1849 many of the trees thus planted were alive about Delhi, but all trace of them seems to have disappeared, and no record of the experiments exists, all Government documents at Delhi having been destroyed by the rebels in 1857. An unsuccessful attempt seems to have been recently made to grow the tree in the Queen's Gardens, Delhi.

The tree was re-introduced into the Punjab by Mr. George Ricketts, some of the seed imported by that gentleman in 1862 having been sown at Lahore and Ferozepore. In 1866 Dr. George Henderson stated to the Agricultural and Horticultural Society of the Punjab that there were then four large trees in Lahore in the gardens of gentlemen,—one which was measured was three feet in girth at the ground, and they were all about the same size. One of them was in fruit when Dr. Henderson mentioned the subject. These were the produce of the seed brought out in 1862 by Mr. Ricketts. Trees produced from this seed were still growing at Lahore and Ferozepore in 1873, and in that year Mr. Ricketts sent the Agricultural and Horticultural Society of India some seed obtained from the trees at Ferozepore. Mr. Ricketts says it has been proved that the tree will thrive in the Punjab and the North-Western Provinces.

The seeds, he says, should be well soaked before planting, and the trees, when planted out, should not be too far from each other to ensure their fruiting.

The explanation of this suggestion will be found in para. 13 in Dr. Henderson's memorandum, which is the completest account on this subject which the Government possesses.

Dr. J. L. Stewart in his *Punjab Plants* (ed. 1869) stated that the tree had been introduced into the Punjab some years, and in some parts had thriven

and was spreading though it did not grow rapidly, and had not yet ripened its seed, or indeed produced pods, except in rare instances. "One or two female trees existed, Dr. Stewart says, in one of the Lahore gardens, and were cut down by the owner, Vandal-like, probably because he did not care to be bothered by questions from the Agri-Horticultural Society as to their progress. It is curious that in the bazaars the pods are sold as an astringent medicine under the name *Kharnub Nubti*, probably finding their way from Syria by devious routes."

In a letter dated the 3rd January 1876, the Financial Commissioner of the Punjab reports, that of the carob trees in Lahore, those in the garden of Mr. Ludlam have grown well and produced seed freely; these trees are supposed to have been planted about 1858. The largest is now four feet in girth a yard from the ground, and 25 feet in height.

At Madhopur some trees were planted about eight years ago (1868) in the church grounds. These seeded freely for the first time in 1874, and again in 1875, and five hundred seedlings have been raised. Captain Garstin, Executive Engineer in charge of the Bari Doab Canal at Madhopur, proposes to form a plantation of young trees on the bank of the canal where they can be irrigated. A few trees were planted out on the canal, and were alive at the end of the year. Captain Garstin says that they ought to be planted tolerably close together, to admit of fertilisation, and that they should be protected from cattle, which are very partial to the leaves, browsing on them freely. Seedlings and seeds are now available at Madhopur for distribution.

The Financial Commissioner further reports that "there are many carob trees in the Shahpur district in the church compound, and the Government garden at Sodi, in the Salt Range. The former are apparently, or were in 1872, all of one size, and did not fruit. Those at Sodi fruited freely, and Mr. Egerton has received seed from the Shahpur district, which has germinated in England."

12. The latest experiment in the Punjab, as in the North-Western Provinces, is due to Mr. W. S. Halsey, who last year presented to the Government of the Punjab a quantity of seed obtained by him while in Italy during that year accompanying the gift with the following memorandum on the cultivation of the plant prepared by the Italian Department of Agriculture and Commerce:—

"The carob is an evergreen; it belongs to the order of Leguminosæ, and resembles the tamarind in some of its characteristics.

"The size of the tree varies with the climate and the soil where it is cultivated. In Central Italy, where it is difficult to make it fruit, it seldom grows above 20 to 25 feet. In Southern Italy it reaches 36 to 40 feet and possibly higher. It is easily cultivated by sowing in the open ground or in suitable pots, and the young trees need not be finally planted out for four or five years.*

"The habit of the plant is to grow very bushy near the roots, but provided the shoots at the base are taken off, it will grow large and thick above, and will require a space of 15 to 16 feet between each tree.

"The climate best suited to the carob must be hot, and to a certain extent dry, and with these qualities it is immaterial whether the land be level or hilly.

"It bears its first fruit when it is about ten years old, and gives its largest crop between the ages of fifteen and twenty years, but it goes on yielding for many years, as it lives to a great age.

"The cultivation is very much restricted to the south of Italy, with the exception of the provinces of Savona and San Remo in Northern, and Portoferraio in Central Italy. It is grown also in the provinces of Cagliari and Sapari in Sardinia,—not, however, to any very great extent.

"The cultivation is very important in Sicily, especially at Modica and Noto.

"The annual produce in these two districts is estimated at 52,500 tons, of which a large portion is exported to England.

"The districts in Southern Italy which cultivate the largest quantity of carob are in the plain of Puglia, in fact the neighbourhood of Bari produces annually 8,750 tons, which are generally exported to foreign parts, and the neighbourhood of Foggia 150 tons, ordinarily exported to Venice and Trieste.

"In Italy the carob is used as food for beasts, especially for mules and horses, particularly for horses, because they feed the mules, which they work very hard, on oats and barley, and in some places with beans.

"Horses which are let on hire are generally fed all the year round on carob seed mixed with bean in the proportion of one-third to one-fourth.

"In some places the poorer classes use it as food, but this is to an insignificant extent.

"The income derived from a hectare of land cultivated with the carob is, according to Professor Ottari, larger and more certain than that of the better kinds of forage, because the tree can bear the heat better than green crops.

* In this case it would be advisable to shift the plant each year.

"The produce of the carob tree, well manured and deeply trenched during the first year (because in after years the roots become too superficial), is at least about 9 tons the hectare,—that is equivalent, as regards nourishment, to 44 tons of green food.

"The foliage also of the tree serves as food for the beasts. Alcohol is distilled from the seed, and an excellent oil for burning is also extracted from them. The bark is used for tanning.

"At Naples they use the wood for constructing wheels with teeth and also for furniture.

"The annual production of the carob in Italy Proper is calculated at 79,750 tons, and, though large quantities are exported annually, an equivalent amount is imported from Turkey, Greece, Egypt, &c."

13. Dr. Henderson having been asked for his opinion, wrote the note referred to in para. 11. The substance of this note is as follows:—

"The value of this tree for the Punjab depends on the fact that it will grow and thrive in the most arid tracts; that it requires almost no cultivation; and that it prefers excessive heat and a soil containing lime: kunkar soil seems to suit it well.

"*Habit of the tree, Climate, Soil, &c.*—The carob grows to a height of 25 to 35 feet. There are now many trees in Lahore quite 25 feet high. As far back as June 1866, I find in the proceedings of the Agri-Horticultural Society of the Punjab (page xxxvi.) a note of my own regarding a tree in a private garden in Lahore, which had then a stem three feet in girth at the ground.

"The carob is evergreen; it is readily propagated by seed; but I have failed to get either cuttings or layers to strike.

"In the Punjab the seed should be sown towards the end of the cold weather—say in January or February—in a seed bed where it can be watered, or in pots. Most of it will germinate in April and May.

"I find that saline soil or saline well-water kills the young plants. Canal water and soil without *reh* should, therefore, be selected. There is a peculiarity about the germination of carob seed which, no doubt, has something to do with the fact that it is a tree of dry and parched countries. It is this, that of a pound of seed sown in February, three-fourths will germinate within a month or two, more will come up when the rains set in, and some will lie dormant in the ground for one or two years. To cause the seed to germinate quickly, I always soak them in a vessel of water hung up in the hot sun and make the gardener examine them every other day and pick out all those for immediate sowing which have swollen by imbibing water. I have now a quantity of seed gathered last June in Lahore which have been soaked in water exposed to the hot sun daily for 45 days, and, although they have been examined every day, I do not think that a dozen have yet shown signs of germinating.

"The carob is dioecious, in other words, the male, or staminiferous, flowers are found on one plant, and the female, or pistilliferous (fertile), flowers on another. This necessitates grafting to render a solitary tree fertile, but in any case grafting is to be recommended because, just as in the case of the mango and most other fruit trees, varieties don't come true from seed. Several bushels of fruit ripened in gardens about Lahore in June last, but most of the beans were only about half the size of those I have seen in Italy and Malta. They were also much less sweet and very much more astringent, and though I believe they would have been valuable as food for cattle, I found them too astringent to be very palatable.

"This convinces me that if the tree is to be extensively grown here a few good grafted trees must be obtained, and I shall undertake to get them out from Italy if necessary.

"In grafting the usual mode of proceeding is to preserve on each plant in the nursery three shoots only; on two of these female grafts are put, and on the third a graft off a male tree; afterwards the male branch is allowed to grow only just sufficiently to produce enough pollen to fertilise the flowers on the other two or female branches. Where trees are plentiful they fertilise each other by pollen being blown from a considerable distance by the wind, and I have found isolated female trees in Lahore produce abundance of fruit, although no male tree was within several hundred yards as far as I could ascertain.

"The carob likes a dry soil containing lime, but will grow and thrive on almost any *soil that is not marshy*. In damp marshy ground it *dies*; it does not thrive either in Saharunpore or Calcutta. The climate cannot be too hot. I never saw even very young seedlings killed by the hot wind (140° to 160° F.),* except where there was saline matter in the water, or soil, or where too much water was given.

"As to the other limit, I believe it is found that wherever the orange will ripen its fruit without artificial protection the climate is not too cold for the carob. At Lahore on the worst soil about the Central Jail it thrives well, in fact, all over Lahore. On the Salt Range it thrives even better and grows very much more rapidly.

"I believe it has most chance of turning out to be valuable where the olive (kow) grows wild. Carobs, olives, and vines are usually found growing together, and often on ground unsuitable for grain crops. They would all thrive equally well here on what district officers now call unculturable land, and what the people call "bungar." This I have proved at the Central Jail. I have now French olives as large as walnuts; the only two trees I have, bore fruit abundantly last year and this year, and of twenty sorts of the best European vines not one has degenerated in the least. These have all been grown on soil which seven years ago was

* The British Consul in the island of Cyprus, however, says that a too hot and dry season injuriously affects the quantity and quality of the produce.—O'C.

uncultivable. I planted it with thousands of Farash cuttings, but in spite of every exertion all died except one. Now it is covered with vines, which bear as good fruit as I ever saw or ate out of an English hothouse.

"This is the third or fourth attempt which, within my knowledge, has been made to introduce the carob into the Punjab, and unless the experiment is now carried on in a less desultory way than former ones, I doubt if it will have any better results.

"Thirteen years ago I urged on the Agri-Horticultural Society here the advantage of getting a large experiment made with the carob tree. Some bushels of seed were then obtained from Europe, and were distributed. I did not then know that the same thing had been done five or six years before. Almost every year since I came to the province seeds have been sown in the Agri-Horticultural Society's garden and plants distributed, and we now know for certain, not only that it will live and thrive, but that it will fruit freely six or seven years after planting. I therefore trust that an experiment will be made to form a plantation of 50 or 60 acres on some of the waste land about Lahore, where it would be within half an hour's ride of all the Government officers. If put away in the desert, it will be lost sight of and forgotten within five years, until some energetic officer re-discovers it.

"I merely mention this to show that the plantation should be close to head-quarters, so as to excite and keep up an interest in it. Had Government seen fit to encourage the starting of the jail farm proposed by me four years ago, such an experiment could have been carried out without almost any expenditure beyond the labour of ticket-of-leave men, and in eight years the actual money value of the tree would have been thoroughly tested once for all. If a quantity of the seed is now made over to me at the jail, I can raise plants in large pots. They will not cost, pots and all, above Rs. 250 per 10,000. If afterwards it is decided to form a plantation of these and of European olives, the waste ground can at any time be purchased for a trifle.

"The Punjab now abounds in corn. I doubt if it ever will abound in vine, unless it be grown in Kashmir; but oil is now very scarce and of very inferior quality, and, as pasture land gets encroached on by grain crop, the supply of butter will probably get less and less up to a certain limit when green crops will become more extensively grown; but there can be no doubt that in many submontane districts the olive would yield an enormous amount of oil fit for human food; and if the introduction of the carob is to be carried out systematically, as in the case of tea and chinchona, the olive should be introduced along with it, or rather multiplied, for the plants introduced by me in 1867 have now increased to thousands I believe.

"I should mention that ten days ago I received from the Assistant Secretary to Government several pounds of the carob seed lately sent out by Mr. Halsey. I sowed it all the day after I received it, having soaked it a night in tepid water. I did not expect much of it to germinate till spring, but I am happy to say every single seed has come up, and most of them have opened their seed leaves."

The result of Dr. Henderson's paper was, that the Financial Commissioner recommended that the experiment suggested should be tried on suitable ground near Lahore, and in compliance with this suggestion 35 acres of land near Government House were made available for the purpose. The Conservator of Forests was then supplied with five seers of seed, and told to form a plantation. In June last year operations were commenced and a considerable portion of the land sown with seed.

14. In Madras the introduction of the tree, as food for cattle, was suggested by Sir Gaspard le Marchant, Commander-in-Chief of the Madras Army, in 1866. At that time there were some plants in the garden of the local Agri-Horticultural Society, raised from seed brought from Cairo in the previous year by Dr. G. Bidie. A further supply was obtained in 1866 from Malta, and packets were distributed through the Board of Revenue to the Collectors of various districts. Dr. Bidie also said that as the Society was in a position to give the plant, which promised to be so useful, a fair trial, no pains would be spared to render the experiment successful. The result of the Society's experiments is thus reported in a letter from the Honorary Secretary, dated 13th August 1875:—"From that date [*viz.*, October 25, 1866] nothing further appears in the records of the Society, but from report it is ascertained that the seed germinated and several healthy plants were raised which subsequently died." And I will note in this place that of all unsatisfactory experiments conducted in India, those conducted under the direct supervision of Agricultural and Horticultural Societies have been the most unsatisfactory.

The seed distributed by the Board of Revenue was sent to Nellore, Bellary, Kurnool, North Arcot, Cuddapah, Salem, Trichinopoly, Coimbatore, Tinnevelly, Madura, South Canara, Oossoor, and Sydapet. The results were reported on in 1867 and 1868, and are as follow:—

In Trichinopoly no record remained of what had been done with the seed, except that about three dozen had been made over to one of the residents and

sown by him. They germinated, but soon died off or were eaten by insects. Five were still alive in 1867, but in a bad way, and no further record of these exists.

In Bellary the seed was distributed to the tehsildars and to a European gentleman. The result was a failure. The seed either did not germinate, or the seedlings soon died off.

In Coimbatore and Nellore the seed was given to ryots, and none of it germinated.

In Tinnevelly and Cuddapah none of the seed germinated.

In Madura the seed either did not germinate, or the seedlings died off at once.

In North Arcot sixteen healthy young plants were obtained. Of these six were lost "from the attacks of white-ants and other mischances." The remainder looked healthy and vigorous, and had attained six feet in height in December 1868. These trees were then in the Government garden at Chittoor, and had been seen a month previously by Dr. Cleghorn, who "thought very highly" of them. No further record of these is to be found in the papers.

In Kurnool the seed was sown by an officer, and the seedlings were coming on well, when he was suddenly ordered to Abyssinia, and forgot in the hurry of leaving to recommend them to somebody's care. The result of course was, that they came to grief. Two were still alive when the officer returned, although they had been completely neglected. He was confident that the seedlings would have thriven if ordinary care had been given to them, and that they would succeed in that district.

In South Canara (Mangalore) the seedlings soon died off, "being apparently unable to penetrate the hard laterite soil."

In Salem (Oossoor) only one seed germinated, and that soon died off.

15. Of the other experiments there appears to be no record. The most recent papers on the subject inform us that—

(1)—There are ten young trees on the Pulneys raised from Italian seed, but the elevation at which they are growing (6,000 and 7,000 feet) is against their success.

(2)—In North Arcot an experiment conducted by the Collector failed, the seedlings dying off.

(3)—At Aska, in Ganjam, Mr. Minchin, the owner of a sugar factory and distillery, has sown some seed in his garden, with apparent success so far.

(4)—There are upwards of two dozen plants in the Government Gardens at Burliar, on the Nilgiris, "all of which are healthy and making vigorous growth." Some of these are nearly four feet high. There are also twenty-seven small plants in the coffee estate of Colonel Scott, at Thymullay, on the southern slopes of the hills. Some of these on the upper part of the estate are not very vigorous, and being at too great an altitude their ultimate success is doubtful. The others lower down are reported very healthy. The Superintendent of the Botanical Gardens thinks the tree could be grown in the coffee districts of Wynaad and Mysore.

No experiments seem to have been tried in any of the other districts from which reports have been furnished by the forest officers. One of these officers (a Deputy Conservator) says: "I am unable to identify the tree by the botanical name given [*Ceratonia siliqua*]. Neither Drury's nor Balfour's works contain the name, so far as I can observe, and these are the only books of reference in this office" (The tree is noticed in Balfour's Cyclopædia, 2nd ed., vol. I., p. 111.)

16. In the Central Provinces an experiment appears to have been made by the Deputy Commissioner of Narsinghpur in 1873 with seed supplied to him by the Agricultural and Horticultural Society of India which the Society had received from Mr. Ricketts. From this seed seventeen plants were raised, but not more than three survived, the others having been destroyed by white-ants, "which are very numerous and destructive at Narsinghpur." The survivors are healthy and likely to prosper. One is six and the two others more than four feet high.

The Deputy Commissioner believes that the tree would grow freely in that district, and that the experiment would have been completely successful, but for the white-ants. No experiments appear to have been tried elsewhere in the Central Provinces.

17. In Bengal the experiment appears to have been repeated two or three times. In September 1873 Mr. Ricketts presented the Agricultural and Horticultural Society with some seed, but what came of it, except that some was sent to the Deputy Commissioner of Narsinghpur in the Central Provinces, does not appear.

In March of the present year Mr. Ricketts presented the Society with thirty seedlings of the tree. These, I have ascertained, are in the garden of the Society at Alipore in a more or less unhealthy condition.

The tree will probably not succeed in the water-logged soil of the Lower Provinces of Bengal, and it would be well if these plants could be transferred to the North-Western Provinces.

Dr. King, Superintendent of the Botanical Gardens, reports, in reply to a reference made to the Government of Bengal, that "private attempts are said to have been made to introduce the tree in this province. There is at present one small tree in this garden, and within the past year I have sown a good many seeds. The tree is of slow growth, so that it will be years before any result can be got from these. I do not, however, think it likely that the carob will thrive in the Gangetic delta, of which the climate and soil are so totally different from those of the countries where the carob flourishes." And he mentions Oudh, the Punjab, and the North-Western Provinces as much more likely to suit the carob than Bengal.

18. In Oudh the tree seems to have done remarkably well at Lucknow. In his report for 1871-72, Dr. Bonavia stated that he had an avenue of 33 of these trees raised from seed imported many years ago. Some of them were 18 and 20 feet high, and in very healthy condition. Eleven fruited during the year, and again more abundantly during the following year. Dr. Bonavia tried to propagate the tree by layers, but found, as has been found by everybody, that the only efficacious mode of propagation is to raise it from seed. In his report for 1873-74, Dr. Bonavia records that the tree stands frost better than was supposed. On the morning of the 8th January, when the minimum thermometer on the grass indicated 5° 3′ below the freezing point, and vast damage had been done to other plants, not a leaf of the carob trees was touched by the frost.

19. On the 20th October last, Her Majesty's Secretary of State for India was asked to obtain from Southern Italy and send out to this country one hundred pounds of fresh seed. This seed is intended for the Government of the North-Western Provinces, which proposes to grow the tree in Kumaun. It seems doubtful, however, whether the tree has a fair chance of success there, and it may be advisable to consider now what had best be done with the seed when it comes. I would venture to suggest that some should be sown in various parts of the North-West and Punjab, the Central Provinces, and Madras. In this last province the failure of the experiments already made undoubtedly resulted from carelessness and ignorance. No seed given to tehsildars and cultivators anywhere has the least chance of success. Over and over again it has been demonstrated that seed entrusted to "intelligent ryots" might just as well have been thrown into the sea. It is unnecessary to discuss the reason of this result; it is sufficient for the present to say that the result is almost invariably the same. I would venture to suggest that no seed should be distributed to any body, European or native, but that it should all be sown carefully in pots in some central spot or spots under careful professional supervision, and that the seedlings should be distributed in due time when properly established. This course would, no doubt, be at first more expensive than that which has been hitherto adopted, but ultimately it would, I believe, be found more economical. The seed might be sown at Lahore, Allahabad, Saharunpore, Nagpore, and Burliar (the Government gardens), and the seedlings be distributed thence from time to time. I would also suggest that good use might be made of the agency of station masters on the lines of railway, both State and guaranteed. The country all along the north-eastern extension of the Madras Railway, from Madras to Raichore, seems well adapted for the growth of the carob, and much in want of a tree of the kind. It is a dry, stony country where water is scarce, and is mostly only

to be had from tanks (which are chiefly natural hollows embanked at the lowest end). In this tract failure more or less complete of the crops is of not unfrequent occurrence, and the cattle are the first and principal sufferers. Groves of trees here which would provide them and their owners with food in times of scarcity would be a great blessing. If the seedlings were planted about the stations, where there is always sufficient water, and where they would be subject to frequent inspection by officers of the district and of the railway passing to and fro, they would be much more favourably situated than if planted in some out-of-the-way taluk where they would languish neglected and out of sight. Some little inducement to station masters, of the nature of that which has resulted in the embellishment of the stations of the Great Indian Peninsula Railway, would probably ensure unintermitting attention from the station authorities. In such places too, forming points of resort for natives from all parts of the district, a general acquaintance with the qualities of the tree would soon be formed and spread through the country.

These remarks may also be held to apply to the State lines of railway in the Punjab, the North-Western Provinces, and Rajputana, which afford even greater opportunities for success in this undertaking. Canal and Forest officers also might be entrusted with seedlings, and held personally responsible that due care is given to them.

J. E. O'CONNOR.

SIMLA,
10*th April* 1876.

BOMBAY BRANCH
OF THE
Royal Asiatic Society.
CLASS 21. August 76

The Carob Tree (Ceratonia siliqua), *with reference to its cultivation in India.*

Government Central Press.—No. 141 R., A. & C.—7-6-76.—750.

No. 11

Extract from the Proceedings of the Government of India in the Department of Revenue, Agriculture, and Commerce, dated Simla, the June 1877.

AGRICULTURE AND HORTICULTURE.

READ—

A memorandum on Sorgho *(Sorghum Saccharatum)*, by Colonel E. Boddam, dated the 22nd May 1871, and revised in July 1872.

Certain papers containing reports on the experimental cultivation of Sorgho in India.

A Note by Mr. F. G. Wigley of the Department of Revenue, Agriculture and Commerce, dated the 1st May 1877.

RESOLUTION.

THE results of the experiments made in India with Sorgho exhibit considerable differences in various parts of the country, and the opinions of local officers regarding the capabilities of the plant also vary considerably, but there does not seem to be any reasonable doubt of the great value of Sorgho as a forage plant when grown under proper conditions. When grown on poor soil insufficiently irrigated and manured it seems hardly, if at all, superior to the common *jowar*, to which it is closely allied; and to maintain the superiority of the plant as displayed in China, in the United States, and elsewhere, high cultivation seems to be essential.

2. The experiments which have succeeded best have been those undertaken in the Punjab, and His Excellency the Governor General in Council requests that the Local Government of that province will continue the experiments in a systematic way, all reasonable effort being at the same time made to acquaint native agriculturists with the subject and (practically) with the uses of the stalks and leaves of the plant as fodder. The plant should also be grown systematically by the Military authorities in the Punjab under the supervision of the Commissariat Department, the produce being utilized for the sustenance of the draught cattle of the Department, and reports on the cultivation throughout the province should be submitted to the Government of India in this Department half yearly.

3. His Excellency in Council is disposed to recommend to the Government of Madras the expediency of continuing the cultivation of the plant at Húnsúr under the supervision of the Commissariat officer stationed there. The climate of Húnsúr seems to be adapted to the plant, and the produce realized from any experiments made might be utilized on the cattle-breeding farm at the station.

ORDER.—Ordered, that copy of the above Resolution, with fifty copies of the Note read in the preamble, be forwarded to the Government of the Punjab, and that copy of the Resolution with thirty copies of the Note be forwarded to the Military Department.

Ordered also, that copies of the Resolution and of the Note be forwarded to the Local Governments and Administrations noted on the margin, with the remark that if they are desirous of making further experiments with Sorgho, seed is available in the Punjab.

Government of Madras (with 40 copies of the Note).
" of Bombay, ditto.
" of Bengal, ditto.
" of the North-Western Provinces and Oudh, (with 40 copies of the Note).
Chief Commissioner of the Central Provinces (with 30 copies of the Note).
" " of British Burma (with 30 copies of the Note).
" " of Mysore and Coorg (ditto).
" " of Ajmere (with 20 copies of the Note).
" " of Assam (ditto).
The Resident at Hyderabad (with 30 copies of the Note).

(True Extract)

G. H. M. BATTEN,

Offg. Secretary to the Government of India.

1877

DEPARTMENT OF REVENUE, AGRICULTURE AND COMMERCE.

AGRICULTURE AND HORTICULTURE.

To

RESOLUTION.

No.

Dated Simla, the *June* 1877.

SUBJECT.

CULTIVATION of Sorgho *(Sorghum Saccharatum)* in India.

Govt Central Branch Press, Simla.—No. 345 R. A. & C.—15-6-77.—250.

Digitized with financial assistance from the
Government of Maharashtra
on 18 July, 2018